School of Mines and Metallurgy

University of Missouri

CATALOGUE
1907-1908

ROLLA, MISSOURI

NORWOOD HALL

THIRTY-SEVENTH ANNUAL CATALOGUE

OF THE

School of Mines and Metallurgy

A DEPARTMENT OF THE

UNIVERSITY OF MISSOURI,

ROLLA, MO.

1908

NEW ERA PRESS,
Rolla, Mo.

Calendar, 1908

JANUARY.

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CALENDAR

1908.

January 2, Thursday ..... Second Term Begins.
February 22, Saturday..... Holiday.
March 16, Monday..... Third Term Begins.
June 10, Wednesday..... Annual Commencement.
September 19 and 21, Saturday and Monday..... } Entrance Examinations.
September 22, Tuesday..... First Term Begins.
October 1, Thursday ..... } Quarterly Meeting of Curators.
November 26, Thursday ..... Thanksgiving Holiday.
December 23, Tuesday, at 4 P. M... Christmas Recess Begins.

1909.

January 5, Tuesday, 8 A. M... ....Second Term Begins.
February 22, Monday ..... Holiday.
March 22, Monday ..... Third Term Begins.
June 9, Wednesday..... Annual Commencement.

VIEW ON CAMPUS

BOARD OF CURATORS

To January 1, 1909.

David R. Francis.....St. Louis, Mo.
Campbell Wells .....Platte City, Mo.
C. B. Faris.....Caruthersville, Mo.

To January 1, 1911.

Walter Williams .....Columbia, Mo.
B. H. Bonfoey.....Unionville, Mo.
J. C. Parrish.....Vandalia, Mo.

To January 1, 1913.

J. V. C. Karnes.....Kansas City, Mo.
P. E. Burton.....Joplin, Mo.
S. L. Baysinger.....Rolla, Mo.

OFFICERS OF THE BOARD

C. B. Faris.....President.
J. V. C. Karnes.....Vice-President.
J. G. Babb.....Secretary.
R. B. Price.....Treasurer.

EXECUTIVE COMMITTEE

OF THE

SCHOOL OF MINES AND METALLURGY

C. B. Faris.....Caruthersville.
J. C. Parrish.....Vandalia.
P. E. Burton.....Joplin.

OFFICERS OF THE COMMITTEE

C. B. Faris.....Chairman.
Charles L. Woods.....Secretary.
Henry Wood .....Treasurer.

Director of the School,
LEWIS E. YOUNG.

Secretary of the Faculty,
JOHN B. SCOTT.

Librarian,
JESSIE HELLER.

Superintendent of Grounds and Buildings,
ROBERT R. DICKERSON.

RICHARD HENRY JESSE, LL. D., *President of the University.*
LL. D., Tulane University, 1891; LL. D., University of Wisconsin, 1904; LL. D., South Carolina College, 1905; LL. D., Missouri Valley College, 1906.

ALBERT ROSS HILL, A. B., PH. D., LL. D. { *President-Elect of the University.*
A. B., Dalhousie University, 1892; Ph. D., Cornell University, 1895; LL. D., University of South Carolina, 1905.

LEWIS EMANUEL YOUNG, E. M.....*Director.*
B. S. in Mining Engineering, Pennsylvania State College, 1900; E. M., Iowa State College, 1904.

GEORGE REINALD DEAN, C. E..... *Professor of Mathematics.*
C. E. 1890, B. S. 1891, School of Mines.

AUSTIN LEE MCRAE, S. D.....*Professor of Physics.*
B. S. University of Georgia, 1881.
S. D. Harvard University, 1886.

VICTOR HUGO GOTTSCHALK, M. S.....*Professor of Chemistry.*
B. S. 1898, M. S. 1900, School of Mines.

ELMO GOLIGHTLY HARRIS, C. E..... { *Professor of Civil Engineering.*
C. E., University of Virginia, 1882.

HAROLD BARTLETT LITCHMAN, S. B... { *Professor of Mining Engineering.*
S. B., Massachusetts Institute of Technology, 1903.

DURWARD COPELAND, S. B.....*Professor of Metallurgy.*
S. B., Massachusetts Institute of Technology, 1903.

LEON STACY GRISWOLD, A. B., { *Assistant Professor of Geology and Mineralogy.*
A. B., Harvard University, 1889.

JOSEPH HENRY BOWEN..... { *Assistant Professor of Shop Work and Drawing.*
Graduate Miller School, Va.

LEON ELLIS GARRETT, B. S..... { *Assistant Professor of Mathematics.*
B. S., School of Mines, 1901.

FACULTY—Continued

ROBERT CLAIR THOMPSON, M. S..... *Assistant Professor of Chemistry.*
B. S., Westminster College, Pa., 1900.
M. S., School of Mines, 1904.

PAUL JULIUS WILKINS, B. S..... *Instructor in Modern Languages.*
B. S., Michigan A. & M. College, 1869.

JOHN BENNETT SCOTT, B. S..... *Instructor in English and Secretary.*
B. S. in General Science, School of Mines, 1907.

EDWARD STAPLES SMITH, M. E..... *Instructor in Drawing.*
M. E., Brown University, 1904.

THEODORE HERMAN TRAMS, E. M..... *Instructor in Civil Engineering.*
B. S. In Civil Engineering, University of Illinois, 1907.

ANDREW JACKSON SELTZER, B. S..... *Instructor in Chemistry.*
B. S. in Chemistry and Metallurgy, School of Mines, 1907.

GEORGE WATSON COREY, E. M..... *Instructor in Mineralogy.*
B. S. 1893, E. M. 1896, Michigan College of Mines.

FRANK CRAIG LIVINGSTON, LL. B *In Charge of Gymnasium Equipment.*

HORACE THARP MANN..... *Assistant in Chemistry.*

WARD BARR MIX..... *Assistant in Physics.*

HECTOR GEORGE SYLVESTER ANDERSON. *Assistant in Metallurgy.*

BOYD DUDLEY, JR..... *Assistant in Metallurgy.*

DEFORREST DON..... *Assistant in Mineralogy.*

WILLIAM ALBERT BAUERIS..... *Assistant in Surveying.*

ROWE FRANCIS MCCRAE..... *Assistant in Surveying.*

HORACE ASAHEL JOHNSON..... *Assistant in Surveying.*

RICHARD EDWARD ARMSTRONG..... *Assistant in Ore Dressing.*

CLYDE REX WOOD..... *Assistant in Drawing.*

FACULTY COMMITTEES

Admission.
Professors Dean, Wilkins, and Griswold.

Athletics.
Professors Thompson, Bowen, McRae, and Copeland.

Buildings, Plant, and Grounds.
Professors McRae and Harris.

Degrees.
Professors McRae, Scott, and Dean.

Examinations and Schedule.
Professors Bowen, Griswold, and Garrett.

Graduate Courses.
Professors Gottschalk and Copeland.

Theses.
Professors Harris, Litchman, Copeland, and Griswold.

Undergraduate Courses.
Professors Dean, McRae, Griswold, and Gottschalk.

HISTORY

In 1870 the General Assembly of Missouri, in accepting the donation of land for educational purposes made by the General Government through an Act of Congress, approved July 2, 1862, established an Agricultural and Mechanical College and a School of Mines and Metallurgy. The design of these institutions is set forth in the following language:

Objects of the Colleges.—The leading objects of said colleges shall be to teach such branches as are related to agriculture and the mechanic arts and mining, including military tactics, and without excluding other scientific and classical studies, in order to promote the liberal and practical education of the industrial classes in the several pursuits and professions of life. (R. S. 1899, Sec. 10504-10521.)

The *School of Mines and Metallurgy* was located at Rolla, Phelps County. Here, in November, 1871, the school was formally opened.

The statues fix the *status* of the School as one of the *Colleges* of the State University. Its affairs are under the immediate supervision of an Executive Committee, consisting of three members of the University Board of Curators, selected by that body.

The need of general culture as a foundation and accompaniment of specifically technical training, led to the establishment, in 1885, of an Academic Course in compliance with the following Act of the General Assembly:

Academic Course of Study, Etc.—That the obligations of the State to the General Government, assumed by the acceptance of the land grant of July 2, 1862, may be more fully discharged, and in order to promote the liberal and practical education of the industrial classes in the several pursuits and professions of life, the Board of Curators of the State University shall prescribe and adopt a liberal Academic Course of Study to be taught in the College of Mines and Metallurgy, located at Rolla, in addition to the courses now taught in said

school, and may confer the degree of Bachelor of Science upon all students who shall complete said course in said school to the satisfaction of the faculty thereof. (R. S., Sec. 10504-10521.)

The School of Mines is organized and conducted with a view to subserving, as efficiently as possible, the ends set forth in the legislative enactments in reference to it.

FINANCES

The proceeds from the sale of the public lands granted by the General Government amount to about $350,000, which is invested in State certificates of indebtedness bearing 5 per cent interest. The School of Mines receives one-fourth of the yearly income thus accruing.

By an Act of Congress, approved August 30th, 1890, commonly known as the "Morrill Bill," the General Government donated to each State and Territory maintaining a college or colleges in accordance with the act of July 2d, 1862, $25,000 a year. After deducting one-sixteenth of this fund for the Lincoln Institute, Missouri gives one-fourth of the remainder to the School of Mines.

In 1891, the Government returned to the various States the sums collected from their citizens by the imposition during the Civil War of a "direct tax." The amount thus refunded to Missouri was $646,958.23, and the 36th General Assembly of the State won the gratitude of the friends of higher education by establishing this as a permanent endowment for the State University at Columbia, and the School of Mines and Metallurgy at Rolla. One-fifth of the income from this endowment, amounting to $6,469.58 per annum, is received by the School of Mines.

The Fortieth General Assembly of the State passed an act providing for a tax on collateral inheritances for the benefit of the State University, and the Forty-first General Assembly has provided that one-fifth of the funds derived from this tax shall be appropriated for the benefit of the School of Mines.

ENDOWMENT

The State endowment of the School of Mines is set forth in the following extracts from the Statutes of Missouri:

"The proceeds of the sale of lands donated to the State of Missouri by the United States for the support of the college of agriculture and mechanic arts and the School of Mines and Metallurgy, by act of Congress, approved July 2, 1863, represented by State certificates of indebtedness, of the following amounts and dates:

July 2, 1883	$242,000.00
November 1, 1883	5,000.00
January 29, 1884	5,000.00
April 19, 1884	35,000.00
April 2, 1885	5,000.00
February 25, 1886	5,000.00
January 1, 1888	5,000.00
December 15, 1888	5,000.00
May 15, 1889	5,000.00
July 1, 1891	5,000.00
May 15, 1893	5,000.00
July 1, 1895	22,881.19
April 9, 1895	5,000.00
Representing a total of	$349,881.19

Now issued or any certificates which may hereafter be issued under any general or special act of the General Assembly; one-fourth of the interest of these funds shall be paid to the Treasurer of the School of Mines and Metallurgy, at Rolla, for the maintenance of said institution."

"The proceeds of sales of lands donated to the School of Mines and Metallurgy at Rolla, represented by the State certificate of indebtedness of $2,000, dated April 15, 1893, issued under act March 31, 1883, interest on which shall be applied to the maintenance of the School of Mines and Metallurgy at Rolla."

"The State certificate of indebtedness of $3,000, issued under act of April 1, 1895 (pages 278 and 281, Laws 1895), dated April 1, 1896, four-fifths of the interest to be applied to the maintenance of the State University at Columbia and one-fifth to the School of Mines and Metallurgy at Rolla, and also any other certificates which may hereafter be issued and held in trust for this fund under any general or special act of the General Assembly." (R. S. 1899, Sec. 10522.)

"The State certificate of indebtedness of $646,958.23, derived from 'direct tax' received from the United States, dated April 1, 1891, issued under act of March 26, 1891, four-fifths of the interest

to be applied for the maintenance of the State University at Columbia, and one-fifth for the School of Mines and Metallurgy at Rolla." (R. S. 1899, Sec. 10522.)

"All sums collected under the provisions of An Act of Congress approved August 30th, 1890, commonly known as the 'Morrill Bill,' shall be paid as follows: One-sixteenth thereof for the benefit of the Lincoln Institute and one-fourth of the remainder to the Treasurer of the School of Mines at Rolla, Missouri." (R. S. 1899, Sec. 10533.)

Collateral Inheritance Tax.—"The moneys received by the State Treasurer under the provisions of this article shall be deposited in the State Treasury to the credit of the fund now existing in the State Treasury, and Known as the 'State Seminary Moneys,' for the maintenance, support and better equipment of the buildings, apparatus, books, instruction, etc., of the University of the State of Missouri, to an amount not exceeding in any one year the equivalent of one-tenth of one mill for every dollar of the assessed valuation of taxable property of the State for the said year: **Provided,** that one-fifth of all such moneys so received shall be devoted to the use of the School of Mines and Metallurgy, a department of the said University." (Session Acts, 1901, Section 302.)

LOCATION

The School of Mines is situated at Rolla, the county seat of Phelps County, on the St. Louis and San Francisco Railroad, approximately half-way between St. Louis and Springfield.

Rolla is on the crest of the Ozark uplift. It has an elevation of eleven hundred forty feet above the sea level, and enjoys an agreeable and notably healthful climate. Its position on a great transcontinental railway system renders it readily accessible from all quarters.

The School is within easy reach of the important mining districts of the State, which offer splendid facilities for the study of Mining Geology, Mining Methods, Ore Dressing, and Mining Machinery. Numerous recent improvements, due to the systematic study of Missouri ore deposits, methods of ore treatment, and the extensive development of low-grade lead and zinc ores have given the school advantages for the

CHEMICAL HALL

application of the theories of Geology, Mining, and Ore Dressing to practice.

The smelting industry of the State is very important and every courtesy is extended to the professors and students of the school in their visits to these metallurgical plants. The methods of mining coal and clay can be readily studied in Missouri and the adjoining fields. Numerous clay working and cement plants in St. Louis and the vicinity offer good opportunity for the study of these important industries. In and about St. Louis are also varied chemical plants which are visited from time to time.

CAMPUS AND ATHLETIC FIELD

The grounds of the School of Mines are situated in the highest part of the City of Rolla, and are over twenty-seven acres in extent. The campus contains beautiful lawns, groves of native oak, and is adorned and surrounded by hundreds of ornamental shade trees.

The athletic field has a good baseball diamond, a football gridiron, tennis courts, a 220-yard oval running track and a 200-yard stretch for sprints and hurdles. On the athletic field there is a suitable building providing shower baths and a dressing room for the various athletic teams.

BUILDINGS AND EQUIPMENT

There are ten buildings located on the enclosed campus:
Mining Building.
Chemical Hall.
Rolla Building, Museum and Geological Survey.
Workshop.
Director's Residence.
Mechanical Hall.
Norwood Hall, Engineering Building.
Heating and Power Plant.
Ore Dressing Building.
Temporary Athletic Building.

MINING BUILDING

The building provided for the Department of Mining is a handsome tile-roof, press-brick structure, and consists of two distinct portions, one containing offices, a class-room, and laboratories; the other comprises a large mill room and mining laboratory, an engine-room, and a boiler-room.

Offices.—Suitable offices are provided in this building for the Department of Mining Engineering and for the Superintendent of Buildings and Grounds.

Lecture Room.—The class room for this department is well equipped with models, maps, drawings, photographs, and samples. Compressed air at one hundred pounds pressure is piped to this room and can be used for demonstration purposes.

Laboratories and Mill Room.—A special laboratory is provided for investigation and thesis work. The mill room is equipped with first-class machinery for the crushing and concentration of ores. The plant contains a Knowles Magnetic Separator, a Dodge Rock Breaker, a Webb City Crusher, Cornish Rolls, three sets of Sample Rolls, a Stamp Battery with Automatic Feeder, Hydraulic Classifiers, Spitzkasten, three New Century Jigs, one Standard Table, one Card Table, one Sperry Slimer, Parsons-Rittinger Percussion Tables, a Frue Vanner, Grinding and Amalgamating Pans and Settlers, Elevators, and Trommels. In addition to this, working models of different types of concentrators have been made by students of the School of Mines and contributed to this outfit. Several thousand blue prints illustrating the design of Concentrating Plants and Ore Dressing Machinery are easily accessible in the School Library.

The Mining Laboratory also includes one Laidlaw-Dunn-Gordon Air Compressor and one Rand Compressor of the Imperial type. These machines furnish compressed air for experimental work in Compressed Air, Transmission, Air Lift Pumping, and Rock Drilling. The department has a large variety of rock drills for experimental purposes and is supplied with rock drill steel of all the standard American, English,

German, and French brands, and also a large variety of high speed tool steels adapted to rotary drilling. The aggregate number of varieties of steels in the laboratory is about one hundred.

The power for the above plant is derived from a 50-h. p. automatic engine and a battery of three Heine Boilers.

Models.—The department has a number of small models, including a stamp battery, a coal tipple, mining cars, a gravity tram, mine timbering, gears, valve motions, head motions, jigs, and tables.

CHEMICAL HALL

The floor space of this building has lately been increased three-fold by the addition of a second story and two wings. The main building is one hundred two feet in length by fifty-five feet in width. Each wing is fifty-five by sixty feet and one story high.

First Floor

The Chemical Lecture Room, occupying the entire south wing, is an exceptionally well lighted room; a long lecture desk with gas and water connections for lecture experiments, and a large glass hood and side desk fit it for demonstration purposes with large classes.

At present this room is also used for general assembly meetings, and for special lectures, its seating capacity being about five hundred.

Stock Room.—The basement under the Lecture Room is used for the storage of the large amount of apparatus, glassware, and chemicals, necessary to operate the department.

Store Room and Dispensing Room.—These are conveniently located in the south end of the main building, and are connected with the Lecture Room and Laboratories. From them supplies and equipment are issued to students.

General Chemistry Laboratories.—These occupy the greater part of the eastern half of the first floor. The larger

one is sixty by thirty feet. It contains four long desks with fifty-two sets of lockers and drawers, also a long line of hoods and a side shelf for stock reagents. The other room, thirty feet square, is equipped with tile-top desks, containing forty-eight sets of lockers and drawers.

The capacity of these two Laboratories is one hundred students, working in two sections.

Qualitative Analysis Laboratory.—The western half of the first floor of the main building is used for Qualitative Analysis. Forty students, each with five or six feet of desk room, can be accommodated at one time. A long line of hoods extends along two walls of the room. Air blast is provided and the room is well ventilated by means of a blower.

Private and Research Laboratories.—There are two Instructors' Offices and Laboratories on this floor. These are small rooms, fifteen feet square, fitted with work benches, hood, water, gas, water pressure, and compressed air.

The north wing of the building, formerly used as the Assaying Laboratory, has been refitted and equipped for research and thesis laboratories.

Second Floor

Main Office and Private Laboratory.—The Department Office and the main Private Laboratory are on this floor.

Sub-dispensing Room.—To better facilitate accurate and rapid work, the supplies for the Quantitative Analysis students are stored away from possible contamination, and are issued from a carefully kept stock in the southeast room on the second floor.

Quantitative Analysis Laboratory.—This laboratory occupies a large room on the western half of the second floor of the Chemical Hall. It is fitted with large double desks each fifteen feet long and will accommodate more than fifty

students at one time. Gas and water are supplied and compressed air furnishes blast for thirteen blast lamps. Along the west wall there is a line of glass hoods. The Balance Rooms are on the north side of the building and contain nineteen first-class balances.

Special Laboratories.—On the north side of the second floor there are several small rooms for special laboratories. These are used largely for electrolytic work and for water analysis.

POWER PLANT AND MACHINERY

The school maintains a first-class power plant which is designed to furnish heat, light, and power, and to pump water for the school. The plant is used also for experimental purposes and comprises a strictly modern and thoroughly equipped laboratory. The boiler plant consists of three 130-h. p. Heine Safety Boilers. The steam engines include a 75-h. p. Ideal Engine, a 35-h. p. Brownell Engine, and a 7-h. p. Davis and Rankin Vertical Engine. A 15-h. p. Otto Gas Engine may be belted to electric generators or used for experimental purposes. The pneumatic equipment includes a Laidlaw-Dunn-Gordon Air Compressor, a Rand Imperial Type Compressor, a 72-in. Ventilating Fan, a 36-in. Ventilating Fan, and a 60-in. Buffalo Forge Blower. There are six Pumps of three different patterns which can be used for power or experimental purposes. The electric generators include a 50-kw. Westinghouse two hundred twenty volt direct current generator, a 3½-kw. one hundred twenty volt generator, a 7½-kw. General Electric direct and alternating current generator, a 2-kw. three-phase Westinghouse generator, and a 1-kw. Westinghouse single-phase generator.

Electricity is commonly used for power in the shops and the laboratories. The electrical equipment includes thirty-five motors varying in size from ½ h. p. to 30 h. p., with an aggregate rating of 150 h. p.

MECHANICAL HALL

This is a two-story brick building one hundred fifty feet by sixty feet, specially designed for mechanical work. The second floor includes a demonstration lecture room, a shop for bench work in wood, and a temporary gymnasium. The first floor contains a lathe room for wood turning, a forge room, a metal working room, and a stock and tool room.

Each floor is provided with a lavatory and lockers and an office for the Superintendent.

Lathe Room.—This room is fifty feet by thirty feet, with an L thirty feet by sixteen feet, and is equipped with twenty Fay and Egan 12-in. swing, college, wood lathes with iron shears. These lathes are fitted up with special fixtures and attachments, designed for this institution. The other machines are a Fay and Egan 27-in. planer, a Fay and Egan bandsaw with 30-in. wheels, an Oliver Universal saw table, two Oliver wood trimmers, a Sterlinger hollow chisel mortise machine, a Beach jig saw, a Brown and Sharpe grindstone, and the necessary benches, specials and tools required for the best work of this character. The machinery in this room is driven by a 30-h. p. electric motor.

Forge Room.—This room is sixty-four feet by thirty feet and contains twenty-four Buffalo Forge Company down-draft forges and is being equipped with a power hammer, drill-press, power shears, emery grinder, modern benches, and small tools, required for the most thorough work of this character.

Metal Room.—This room is sixty-four feet by thirty feet, and is equipped with:

One 20-in. by 8-ft. Reed Lathe.
One 12-in. by 6-ft. Reed Lathe.
One 12-in. by 5-ft. Reed Lathe.
One 14-in. by 6-ft. Hendey Lathe.
One 14-in. by 6-ft. American Lathe.
One No. 2A Brown & Sharpe Universal Milling Machine.

MACHINE SHOP

One Hendey 15-in. Pillar Shaper.
One Dwight Sensitive Drill.
One Barnes 22-in. Swing Upright Drill Press.
One 24-in. Morse Double Emery Grinder.
One 24-in. by 24-in. by 6-in. Chandler Planer.
Two Grunard Arbor Presses, No. 3½ and No. 1.
One No. 1 Burr Cold Saw.
One 3-fire Chicago Flexible Shaft Gas Furnace.

The above mentioned machines are all of the latest design and are driven by individual motors. Each machine has all of the necessary fixtures such as are used in the most modern machine shops. Each lathe has three chucks, and the two tool-maker's lathes have sets of the draw-in chucks.

The benches in the lathe room have hard maple tops mounted on the standard Brown & Sharpe bench legs. Twenty-four machinist vises, twelve of which have the swivel base and jaw, equip the shop for bench work.

Stock and Tool Room.—The tools and supplies for the forge and metal rooms and special tools for the various departments are checked out from a well organized stock and tool room, thirty by twenty-four feet in size.

Wood Bench Work Room.—This room is fifty feet by sixty feet, and is equipped with benches, each fitted with a complete set of hand tools required for this class of work, an instructor's bench, a Brown & Sharpe grindstone driven by an electric motor, and the necessary trestles and clamps.

Demonstration Room.—A room forty feet by forty feet, is equipped so that the instructor can illustrate before the class the actual operations in the shops. This aids materially in giving the student a correct idea of the work before him and enables the instructor to emphasize the important points.

Temporary Gymnasium.—This room is fifty feet by sixty feet, and is provided with the usual gymnasium apparatus.

ROLLA BUILDING

This building was originally built by the City of Rolla as a high school building, but was sold to the State, and for many years was the principal building of the School of Mines and Metallurgy. It is a brick structure, ninety feet by sixty feet, four stories high, including a working basement. It contains the library, laboratories, drafting rooms, offices, and geological collections of the State Geological Survey, Mathematical Recitation Rooms, Toilet, Shower Baths, and Locker Rooms.

NORWOOD HALL

This is a handsome structure, one hundred forty feet by eighty-five feet, four stories in height; built of press brick and cut stone. It is heated and ventilated by the fan system, and is equipped throughout with water, gas, electric, and plumbing fixtures.

It contains adequate quarters for the Administrative Offices and the Departments of Physics, Geology and Mineralogy, Civil Engineering, English, Modern Languages, and Drawing.

The Physical Laboratory occupies the basement floor. In addition to the General Laboratory, there is a Photometer Room, a Constant Temperature Room, a Storage Battery Room, an Electrical Testing Room, and a Laboratory for special work. This floor also contains a Blower and Fan Room, Toilet and Shower Bath Room, a Testing Laboratory, the Petrographical Laboratories, and a Museum.

The first floor contains the Physics Lecture Room, Physics Apparatus Room, an Office, two Lecture Rooms, the Instrument Room for the Surveying Department, the General Library, Library Reading Room, and Cloak and Toilet Rooms.

The second floor contains the Administration Offices, the Faculty Room, the Geology Lecture Room, Geology and Mineralogy Laboratories, Photographic Room, and the Museum.

ROLLA BUILDING

The third floor contains three Lecture Rooms, three Drawing Rooms, and Toilets.

ADMINISTRATIVE OFFICES.—The east end of the second floor is used by the Administrative Department. There is a Director's Office, reception room, stenographers' office, Secretary's Office, and a room reserved for the uses of visiting committees, the Board of Curators, and the Executive Committee of the School of Mines and Metallurgy.

LIBRARY.—The Library contains between six thousand and seven thousand carefully selected volumes and several thousand pamphlets and bulletins. Good collections of works upon Engineering, Mathematics, Chemistry, Physics, Mining, Metallurgy, Ore Dressing, Geology, and Mineralogy, afford to students in these departments an opportunity to pursue an extended course in reading in connection with their class work. The Library also contains the standard works in English and American Poetry, Fiction, Biography, and History. It is well provided with encyclopedias and works for general reference.

The Library is also the depository for the maps, drawings, photographs, and lantern slides of the institution. A splendid series of several thousand photographs of Missouri mines, mills, and smelters is on file and indexed so that it is easily accessible. Photographs have been secured from most of the important mining camps of the world, and the student has the opportunity to supplement the daily lectures by reference to and careful examination of selected illustrations.

The valuable collection of between two thousand and three thousand maps and drawings are indexed and are used to supplement work in the class room and the drafting room.

Current and recent technical literature plays such an important part in present day education that an elaborate card index of technical literature has been provided and is maintained up-to-date. More than 25,000 important articles in

transactions of societies, reports, bulletins, and periodicals have been recorded and classified.

A well lighted room, thirty-nine by forty-five feet, has been furnished in an attractive manner for the Reading Room. It is located on the first floor of the building and is adjacent to the Stack Room. The Stack Room has been recently equipped with new steel stacks, and the library is now catalogued according to the Dewey System.

The Library is open from 9 a. m. to 12 m., from 1 p. m. to 5 p. m., and from 7 to 9 p. m., daily except Sunday.

The following periodicals and newspapers for the current year are found on the reading tables:

Abstract Papers of the American Chemical Society.
Atlantic Monthly.
American Journal of Science.
American Mathematical Monthly.
American Chemical Journal.
American Machinist.
American Blacksmith.
Annales de Chemie et de Physique.
Annales des Mines.
Brick.
British Columbia Mining Journal.
Cassier's.
Cement Age.
Century.
Clay Worker.
Compressed Air.
Chemical News.
Columbia University Quarterly.
Comptes Rendus.
Cosmopolitan.
Electrical World.
Electrician (London).
Engineering Digest.
Engineering News.
Engineering Magazine.

Engineering Record.
Engineering and Mining Journal.
Electric Journal.
Electro-chemical Journal.
Economic Geology.
Everybody's.
Forestry and Irrigation.
Forum.
Ice and Refrigeration.
Iron Age.
Harper's.
Harper's Weekly.
Harvard Engineering Journal.
Journal of the Association of Engineering Societies.
Journal of the Chemical and Metallurgical Society of South Africa.
Journal of Geology.
Journal of the Iron and Steel Institute.
Journal of the Society of Chemical Industry.
Journal of the American Chemical Society.
Journal of the English Chemical Society.
Journal of the Franklin Institute.
Lead and Zinc News.
Library Journal.
Life.
Literary Digest.
London Mining Journal.
London Mining World.
McClure's.
Mexican Mining Journal.
Mines and Minerals.
Mines and Mining.
Mining and Scientific Press.
Mining Science.
Mining World.
Munsey's.
National Geographical Magazine.
North American Review.
Official Gazette.
Outing.
Physical Review.
Philosophical Magazine.
Popular Science Monthly.
Putman's.
Power.
Review of Reviews.

Revue Universelle des Mines.
Salt Lake Mining Review.
Sibley Journal of Engineering.
School of Mines Quarterly.
Science.
Scientific American.
Scribner's.
Stahl und Eisen.
Stone.
Technology Quarterly.
Transactions of the American Society of Civil Engineers.
Transactions of the American Institute of Mining Engineers.
Western Chemists and Metallurgists.
Wood Craft.
World's Work.
Zeitschrift für Electrochemie.
Zeitschrift für Analytische Chemie.
Zeitschrift für Anorganische Chemie.

Newspapers.

Jefferson City Tribune.
Joplin Daily Globe.
Joplin News Herald.
Kansas City Times.
Kansas City Star.
St. Louis Globe-Democrat.
St. Louis Republic.

Geology and Mineralogy.—There are assigned to this department rooms on the second floor and the basement floor of this building. The northwest corner room on this floor is twenty-eight feet by thirty feet, and is used as a mineralogy laboratory, and contains the extensive collections of wooden and glass crystals and the reference and working mineral collections. The southwest corner room, forty feet by forty-five feet, is used by this department as a lecture room, and is equipped with a petrographical projection apparatus and stereopticon lantern. The center room on the south side is used for a laboratory for Lithology and General and Economic Geology. There are also photographic dark rooms and ample store rooms on this floor.

The southwest room in the basement contains the great Geological Relief Map from the St. Louis Exposition, as well

as the polished stone tables and other complete collections of the Missouri building and ornamental stones from the same exposition. A complete collection of the economic minerals of Missouri is here assembled as well as a good economic geological collection representing the world at large.

The Museum on the second floor contains crystals and minerals from various of the important mining districts of the State of Missouri and the economic collections from the Southwest.

The Geological and Mineralogical equipment includes a representative collection of minerals, rocks, and fossils for class use; a large collection of cabinet specimens of minerals and ores, and of materials illustrating metallurgical processes. There have been recently added to the equipment of this department several large Geological Relief Models, which aid materially in the work in stratigraphical and structural geology.

There is also a collection of thirty-five hundred specimens, representing the mineral wealth of Missouri, consisting of ores of lead, zinc, iron and copper, coal, clays of many sorts, and building stones. The minerals occurring as gangue with the metalliferous deposits of the State are also well represented. Altogether, it is an unusually valuable assemblage of geological products of economic importance.

This collection was a part of the Missouri Mineral Exhibit displayed at the World's Fair at Chicago. It was presented to the School of Mines and Metallurgy by the General Assembly in 1895. In addition to the above mentioned collection, the State Board of Equalization assigned to the school the specimens, models, maps, and machinery which constituted the Missouri Mining Exhibit at the St. Louis Exposition, thus giving to the school a large amount of valuable equipment.

A rock section machine and instruments for geological surveys are included in the equipment of this department.

PHYSICS.—The lecture room, the apparatus cabinet room, the library, and study are on the first floor. The lecture room is a large, well lighted room capable of seating one hundred students. The lecture table is provided with water, gas, and electric connections for convenience in lecture demonstrations and experiments.

The Physical Laboratory is on the ground or basement floor. There are two large laboratories, one equipped for general physical measurements in mechanics, sound and heat, and one equipped for electrical measurements. There is a battery room equipped with both primary and secondary batteries connected by wires with the various laboratories and lecture room; a constant temperature room with double walls and air space insulation; a commodious dark room with blackened walls for spectrometric and photometric measurements, and a special laboratory for research work.

The equipment includes a Rowland electrodynamometer with shunts and resistances; a Leeds and Northrup Decade Wheatstone bridge; a Queen & Co., P. O. pattern, Wheatstone bridge; two portable testing sets; various Wheatstone bridges and resistance boxes; standards of resistance inductance and capacity; a Lummer-Brodhun Photometer; a Gaertner dividing engine, with linear and circular attachments; a Threlfall micromanometer; a Duddell thermo galvanometer; various tangent mirror and D'Arsonval galvanometers; a Parr coal colorimeter; a wireless telegraph demonstration set; a ten-inch induction coil; Crooke's tubes; X-Ray tubes; Toepler Holtz machine; a Schmidt and Haensch spectrometer; a Rowland diffraction grating; photographs of Rowland's normal solar spectrum; Crosby, and Schaeffer and Budenberg steam and gas engine indicators; Amsler planimeters; tachometers and speed counters; various balances, micrometers, calipers; together with apparatus for illustrating the principles of physics.

The Dynamo Laboratory contains an assortment of direct current generators and motors, a General Electric double current generator for D. C. and A. C. work, a single and a three

ORE DRESSING BUILDING

phase generator, an induction motor, a rotary transformer, stationary transformers, three phase to two phase transformers and a Cooper Hewitt mercury vapor converter with testing instruments, which include a Weston laboratory standard voltmeter, with multipliers; a Weston laboratory standard millivoltmeter, with shunts; a Kelvin electrostatic voltmeter; Weston portable D. C. ammeters; Weston portable D. C. and A. C. voltmeter; Weston and Thomson portable wattmeters; Thomson A. C. voltmeters; electrodynamometers; a Grassot fluxmeter; inductance coils and condensers.

Civil Engineering.—Civil Engineering occupies the greater portion of the third floor, and embraces two large draughting rooms amply lighted and equipped for the work above the Freshman year; a blue-print room, conveniently arranged for making prints; two large lecture rooms, a department library and study. There is an instrument room on the first floor for storing the instruments in daily use.

The equipment for Field Practice includes thirteen transits and one theodolite, one plane table, one solar compass, one railroad compass, eleven levels, together with barometers, meters, chains, tapes, level rods, tools and other necessary equipment for Field Practice. A number of the transits are adapted for underground surveying.

A laboratory in the basement is equipped with a 100,000-lb. testing machine suitable for making tests on iron, steel, wood, stone, concrete, and clay products. Special equipment is provided for the testing of cements.

ORE DRESSING BUILDING

This is a three-story gray press brick building, forty-five by one hundred six feet, with a basement and two large one-story wings. Although the building has not been completed, two stories and the west wing are in use. The building is to provide quarters for the Department of Metallurgy and

the Department of Ore Dressing. At the present time the Department of Metallurgy is using the west wing and the first and second floors.

Assaying Laboratory.—The west wing is a one-story structure having a floor space of forty-eight hundred square feet. This wing includes the main Assaying Laboratory, a Parting Room, and a Balance Room. The main room is fifty by eighty feet, is well lighted and has a concrete floor. Twenty coal-fired two-muffle furnaces are arranged along the south and west walls of the laboratory. These furnaces use NN muffles and there is one coal-fired three-muffle furnace using QQ muffles, which is set aside for Thesis work. All of these furnaces are fired from the back, and the firing room is separated from the main laboratory, thus excluding coal smoke and dust. There are also twelve gasoline-fired furnaces of various types, ten coke-fired furnaces, and one oil-fired furnace. Desks containing lockers, pulp balances, and fluxes are arranged close to the furnaces. The laboratory is well equipped with buckboards and anvils. A mono-rail system carries coal and supplies and otherwise serves the whole laboratory.

Separated by swinging doors from the main laboratory is a Parting Room, twelve by sixteen feet, and a Balance Room, sixteen by twenty-one feet. The Parting Room contains two Water Stills, Parting Acid Jars, Electric and Gas Hot Plates, and an Electric Muffle for annealling.

The Balance Room is equipped with eleven fine balances of various types, such as the Ainsworth, Smith & Thompson, Henry Heil, Eimer & Amend, and Troemer. North windows give a good light to this room.

The Laboratory is equipped with a 20-in. water jacket blast furnace with Root's Blower, for reduction of lead and copper ores. There is also in this laboratory experimental hand reverberatory roaster, experimental pot roaster, experimental zinc distilling furnace, Deville clay testing furnace, LeChatlier thermo-electric pyrometers, a Wänner optical pyro-

meter, cyanide testing outfit with 100-pound capacity tanks, laboratory tube mill, and laboratory amalgamating pans.

First Floor

Stock Room.—A stock room on the first floor of the main building is conveniently located for the distribution of supplies and equipment for the Assaying Laboratory and the Metallurgical Laboratory.

Metallurgical Laboratory.—The Metallurgy Laboratory on the first floor is thirty-five by forty-two feet. This room is well equipped with hoods and sinks and contains fifty-six desks and lockers. This laboratory is used especially for Senior Metallurgy and for Metallurgical testing of various kinds.

Metallography Laboratory.—This room on the first floor is sixteen by thirty feet and is equipped with two Boston Testing Laboratory Polishing Machines, two Bausch & Lomb microscopes with micro-photographic attachment and an arc lantern. A concrete pier is provided as a microscope stand Numerous alloys are provided for microscopic examination by the students.

The first floor also contains a dark room for metallographic work, and two store rooms.

Basement.—The basement, thirty by forty-four feet, contains a boiler and fuel room and shower baths.

Second Floor

Offices and Private Laboratories.—Offices for Metallurgy and Ore Dressing are provided with suitable private laboratories for departmental and research work.

Metallurgy Reading Room.—A well lighted room is provided for technical catalogues and special literature of value for research work and thesis work.

Electro-Metallurgical Laboratories.—This laboratory occupies a room sixteen by thirty feet, which is wired es-

pecially for experimental purposes. Current for electrolytic purposes is furnished by a motor-driven generator capable of delivering one hundred fifty amperes. Stepped stands are provided for the placing of electrolytic vats. The laboratory is especially fitted for making tests on the refining of copper, lead, and other metals. For tests of electric smelting an electric arc furnace is provided.

The laboratory is well equipped with electrical and high temperature measuring instruments. It is planned to further equip this laboratory in order to increase its value for experimental and research work along electrolytic and electric smelting lines.

METALLURGY LECTURE ROOM.—The class room is equipped with a Brown Coke Furnace, an Electric Resistance Muffle Furnace, Pulp and Button Balances, Hot Plates, and other appliances necessary to demonstrate Assay Lecture Work. Models, Photographs, Drawings, and Lantern Slides supplement the equipment for demonstration. All lectures in this department are carefully illustrated. A seating capacity for seventy students is provided.

ADMISSION

Under the statutes persons of either sex, sixteen years of age or over, whether residents of Missouri or not, may be admitted upon evidence of sufficient preparation. Students should have a good liberal education, its elements at least, before beginning technical study. The average age of members of the present Freshman Class at entrance was about eighteen. Specific requirements have been fixed by considerations of the express design of the school—"to promote the education of the industrial classes" in certain branches of engineering—and of the educational opportunities of its intended beneficiaries. The requirements for admission to the Freshman Class are as follows:

The applicant must file with the Director a satisfactory certificate of good moral standing.

VIEW ON CAMPUS

ADMISSION BY EXAMINATION.—Applicants for admission, not having diplomas from approved schools, are required to pass, without conditions, examinations in fifteen units, a unit being the equivalent of a year's work in one subject, as given in an approved High School.

Of these fifteen units the following are required: Three units in English, two units in Algebra, one unit in Plane Geometry, and one-half unit in Solid Geometry. The remaining eight and one-half units may be selected from the following list:

Subject.	Maximum.	Minimum.
English	4	3
Algebra	2	2
Plane Geometry	1	1
Solid Geometry	½	½
Plane Trigonometry	½	½
History	4	1
Latin	4	1
Greek	3	1
German	3	1
French	3	1
Spanish	3	1
Physics	2	1
Chemistry	2	1
General Biology	2	1
Zoology	2	1
Botany	2	1
Drawing	1	1
Shopwork	1	1
Civil Government	½	½
Physiology	1	1
Physiography	1	1

DEFINITION OF UNITS IN THE SEVERAL SUBJECTS

ENGLISH. The four units that may be offered in English are as follows:

1. *Literature* two periods, *Grammar* two periods, *Composition* one period a week for one year.

2. *Literature* three periods, *Rhetoric* and *Composition* two periods a week for one year.

3. *Literature* two periods, *Rhetoric* and *Composition* three periods a week for one year. The Literature of the first three years should include the masterpieces recommended for college entrance in the North Central States. The masterpieces are:

For general reading: Shakespeare, The Merchant of Venice, Macbeth; the Six Roger De Coverly Papers in the Spectator; Irving, Life of Goldsmith; Coleridge, The Ancient Mariner; Scott, Ivanhoe, Lady of the Lake; Tennyson, Gareth and Lynette, Elaine, The Passing of Arthur; Lowell, The Vision of Sir Launfal; George Eliot, Silas Marner.

For minute and critical study: Shakespeare, Julius Caesar; Milton, Lycidas, Comus, L'Allegro, Il Penseroso; Burke, Conciliation with America; Macaulay, Essay on Addison and Life of Johnson.

4. For the fourth unit the candidate may offer either:

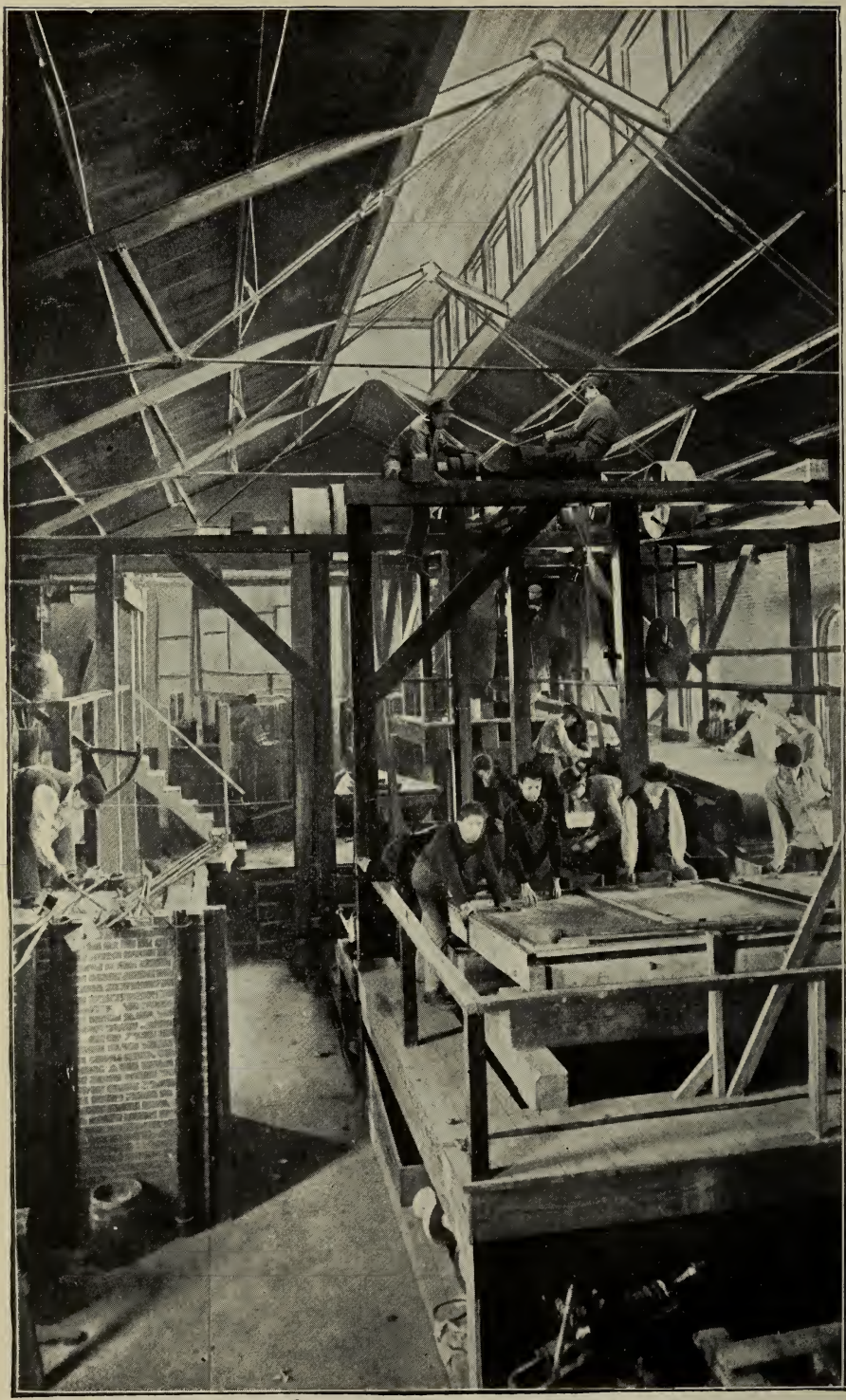
Literature. A year's work in English or American literature in addition to that described under 3; or

History of the Language. A year's work in the history of the language (Lounsbury's or an equivalent text); or

Literature and History of the Language. Half a year's work in each.

MATHEMATICS.—The four units which may be offered in Mathematics are as follows:

Algebra. One unit. Elementary Algebra, including the elementary operations, solution of single and simultaneous



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linear equations, factoring, radicals, exponents (both integral and fractional), and the solution of numerical quadratic equations.

One and one-half units. Complete elements of Algebra, including the above, and in addition, solution of simultaneous quadratics, of higher equations solved as quadratics, of problems whose solution depends upon quadratics; the formation of equations with given roots; the binomial theorem for *positive integral exponents;* logarithms, including the theory and the practical use of logarithms; and ratio and proportion.

The text should cover the ground in the best Algebras, preferably the newer books which contain work on graphs. Books which do not contain all of the above mentioned are sufficient for the first unit, but not for the unit and a half.

Plane Geometry. One unit. The work in Plane Geometry, in order to be acceptable, *must cover a full year* in any good text. It is recommended that part of the year be spent upon the applications of Algebra to Geometry, and of Geometry to Algebra.

Solid Geometry. One-half unit. The work in Solid Geometry, in order to be acceptable, must cover a full half year's work. It is recommended that the work be accompanied by work of semi-laboratory character, including model-making, experimental verification of theorems by weighing, etc. Such laboratory work in mathematics will be allowed due weight in deciding the merits of schools and of individuals.

Trigonometry. One-half unit. This is supposed to cover a half-year in a high-school. It includes the elementary notions, logarithms, functions of obtuse angles, solution of right angled triangles, and some work in oblique triangles. This work will be accepted for admission to the courses requiring Trigonometry, but will not be accepted for advanced standing in the University.

History.—The four units that may be offered in History are as follows:

Ancient History. One unit. The history of the Oriental, Greek, and Roman Periods as given in any standard high school text, such as Myers' Ancient History (Revised edition), Botsford's Ancient History for Beginners, or West's Ancient History.

Medieval and Modern History. One unit. The history of Europe during the medieval and modern periods as given in Myers' Medieval and Modern History or other good text of equal scope.

English History. One unit. The political and social history of the English people as given in any good advanced text. A half unit will be given for work of a less advanced character based on such works as Ransom's Short History of England, or Montgomery's History of England.

American History. One unit. The history of the Colonial and United States periods as given in Channing's History of the United States, or other advanced text. For work of less comprehensive character, only a half unit will be granted.

A half unit in English or American History will be accepted only when accompanied by at least one unit in European History.

Civil Government.—One-half unit may be offered in Civil Government. The equivalent of one-half year's work in the fourth year of a high school. A knowledge of the chief organs of local, state, and national government, their relations to each other, and the important functions assigned to each group. Some knowledge of historical development will be required, and no credit will be given unless the student offers at least one-half unit in American History.

Latin.—The four units that may be offered in Latin are as follows:

1. Collar and Daniel's First Latin Book or the equivalent.

2. Three books of Caesar's Gallic War with composition based thereon in Moulton and Collar's Preparatory Latin Composition or in Daniell's New Latin Composition. For one book of the Gallic War the equivalent in time of Viri Romae, Nepos, or Eutropius may be offered.

3. Two additional books of the Gallic War and four Orations of Cicero with compositions based thereon in the books mentioned above.

4. Ovid's Metamorphoses (2,000 lines) and four books of Vergil's Aeneid, with prosody.

GREEK.—The three units that may be offered in Greek are as follows:

1. Ball's Elements of Greek, or White's First Greek Book.

2. Four books of Xenophon's Anabasis, Pearson's Greek Prose Composition, or its equivalent, Goodwin's Greek Grammar.

3. Ten orations of Lysias and the first four books of Homer's Odyssey, or an equivalent amount of other Greek authors. Bridgman's Parallel Exercises based on Lysias.

GERMAN.—The three units that may be offered in German are as follows:

1. (a) Familiarity with inflection, the more common prepositions, the simpler uses of the modal auxiliary, and elementary word-order and syntax. (These specifications are in no sense restrictive, but are simply suggestive of the thoroughness required.) (b) Ability to translate a passage of simple prose at sight, with the help of a vocabulary of the less usual words. (c) Ability to pronounce German, and to recognize German words and simple phrases when spoken; intelligent and fluent reading of the text.

2. (In addition to 1.) (a) The translation of ordinary German at sight. This presupposes, in addition to the ele-

mentary requirement, the reading of works like the following: *Burg Neideck* (*Riehl*), *Die Journalisten* (*Freytag*), *Wilhelm Tell* (*Schiller*), from 200-250 pages. (b) A thorough knowledge of accidence of the principal values of prepositions and conjunctions, and of the essentials of German syntax—particularly that of the modal auxiliaries and subjunctive and infinite moods. (c) The writing in German of a paragraph upon some subject selected from the works specified above. (d) Ability to follow a recitation conducted in German, and to answer in that language questions asked by the instructor.

3. (In addition to 1 and 2.) (a) The translation of continuous English prose into idiomatic German. (b) A brief essay in German upon one of two subjects from works like the following: Freytag's *Doktor Luther;* Keller's *Dietegen;* Schoenfeld's *Historical German Prose;* Gutzkow's *Zopf u Schwert;* Lessing's *Emilia Galotti.*

FRENCH.—The three units that may be offered in French are as follows:

1. A knowledge of the main principles of grammar, and a good pronunciation; the ability to translate at sight ordinary nineteenth century prose, represented by not less than four hundred pages selected from at least three authors.

2. A year's work in addition to that outlined under 1. The candidate will be required to show proficiency in syntax, the ability to translate at sight standard prose into simple and idiomatic English, and some facility in writing in French short acounts connected with the works read, or in translating from English a passage of connected prose. Special attention should be paid throughout to pronunciation. Texts should be confined chiefly to standard works of the eighteenth and nineteenth centuries.

3. By a third unit in French is meant the results of a progressive study of the language during a third year under the same general conditions as for a second unit. These should comprise the reading of about a thousand pages of standard French, classical and modern; and the writing of

numerous short themes in French, in which the rules of syntax may be correctly observed. The works should be read, not translated, with the exception of the more difficult passages.

SPANISH.—The three units that may be offered in Spanish are as follows:

1. A year's work, with the same requirements in grammar, pronunciation, and reading as for the first unit in French, described above.

2. A second year's work in Spanish, parallel to the second year in French, described above. It is recommended that the choice of texts for the second year be confined chiefly to standard works of fiction from the nineteenth century (Caballero, Alarcon, Valera, Galdos, Valdes).

3. A third unit in Spanish comprises the study of Cervantes, Don Quijote, and Novelas Ejemplares; Quevedo, Suenos; Guzman de Alfarache (Part 1); Lazarillo de Tormes. The last two, if difficult to be found, may be replaced by three plays of Lope de Vega and two of Calderon.

CHEMISTRY.—The two units that may be offered in Chemistry are as follows:

1. A year's work in Chemistry, five periods a week, of which at least two must be devoted to laboratory work.

2. A second year's work in the subject, with periods as above.

Note-books showing work done must be presented by those who are required to take the entrance examination.

These courses will be accepted for Admission, but not for Advanced Standing.

PHYSIOGRAPHY.—If a candidate desires to offer one unit in Physiography, he will be examined according to the following scheme:

Air. Construction and interpretation of weather maps; use of instruments; relation of cyclones to wind direction, rain-

fall, and temperature; presentation of record of temperature and pressure observations kept through one school year.

Ocean. Construction and interpretation of tidal curves from tide tables; interpretation of depth charts and temperature curves.

Land. Determination of ten common minerals from their physical properties; determination of ten common rocks on the basis of mineral compositions and structure; soils—determination of composition of selected examples; sands and gravels—recognition of constituents and derivation; mapping—(a) instruments used, scale, projection, methods; (b) presentation of a detailed contour map, drawn to scale, of at least one square mile, showing, besides relief and drainage, distribution of the various rock beds (limestone, sandstone, shale, etc.), soils (alluvial or non-alluvial), forest trees, etc.; reading of topographic maps with exercises in description of topographic types from study of the maps.

A map of four square miles showing in addition to the subjects shown on the map offered for the first unit, the roads, railroads, farm houses, forest, cleared land, mines, clay pits, and quarries; drawings of the soil and rock exposures in the clay pits, mines, and quarries of his neighborhood, showing the relative position, extent (within the pit or quarry), thickness, and character of each bed; a list and description of the various minerals and rocks found within the area of the map; and an examination and passing grade on the physical features of that part of the United States lying east of the Rocky Mountains.

PHYSICS.—The two units that may be offered are as follows:

1. A year's work, five periods a week, of which at least two must be double periods devoted to individual laboratory work. At least 35 exercises, selected from a list of 60 or more, equivalent to those recommended by the National Education Association, must be completed.

2. A continuation of the laboratory for another year, or a year's work in a more advanced text together with the laboratory work.

Laboratory note-books must be presented by those who are required to take the entrance examination.

DRAWING.—The one unit that may be offered in Drawing is as follows:

A year's thorough work in Freehand Drawing, or in Mechanical Drawing, or in a combination of the two. This out the year. Drawings must be presented by students desir- unit is the equivalent of five laboratory periods a week through- ing credit in this subject for entrance.

Freehand. The ability to draw and paint natural growths (leaves, flowers); to give correct proportions, perspective, and light and shade in drawing from geometric solids, vases, etc.; to paint with water colors from simple objects (fruit vases); to make designs suitable for book covers and school programs, in black and white and in color.

Mechanical. Use of instruments and plain lettering; simple geometrical problems, plain freehand lettering and dimensioning; plans, elevations, and cross-sections; development of the *idea of plan, elevation* and *section* from geometrical solids; drawing accurately to scale plans, elevations, and sections from pupil's own measurements and dimensioned freehand sketches of simple machine parts; plan and elevation of some building measured by pupils. The explanation and practice of isometric and cabinet views as applied especially in joinery.

Combination. The ability to draw, as outlined under the Freehand Course, without the painting; the use of the instruments, plain lettering, the drawing of simple plans and elevations as outlined under the Mechanical Course.

MANUAL TRAINING.—One unit in Manual Training may be offered for admission to any Department except the College of Arts and Science and Law Department. The candidate must give satisfactory evidence of having completed a year's work (five periods a week of at least an hour and a half each) in Manual Training.

Admission on Diploma.—Applicants may be admitted upon certificate from a college, high school, or preparatory school, when the faculty is satisfied that the work certified to covers the requirements of the School of Mines and Metallurgy.

Each applicant must file with his diploma a statement, on a School of Mines and Metallurgy blank, from his superintendent or principal, showing that the applicant has to his credit fifteen units.

Following is a list of schools whose courses have been approved by the University, and whose diplomas will admit to the Freshman Class without examination:

ACCREDITED SCHOOLS

Albany High School.
Alton (Ill.) High School.
Appleton City Academy.
Aurora High School.
Bethany High School.
Blees Military Academy, Macon.
Bloomfield High School.
Bonne Terre High School.
Boonville High School.
Bowling Green High School.
Braymer High School.
Breckinridge High School.
Brookfield High School.
Butler High School.
Cairo (Ill.) High School.
California High School.
Cameron High School.
Carrollton High School.
Carterville High School.
Carthage High School.
Caruthersville High School.
Centralia High School.
Charleston High School.
Chilicothe High School.
Christian College, Columbia.
Clinton High Schooi.
Columbia High School.
Columbia Normal Academy.
Covington (Ind.) High School.
Culver (Ind.) Military Academy.
Davenport (Iowa) High School.
DeSoto High School.
Doniphan High School.
Dexter High School.
Elmwood Seminary.
Enid (Okla.) High School.
Excelsior Springs High School.
Fayette High School.
Flat River High School.
Fort Scott (Kas.) High School.
Fort Smith (Ark.) High School.
Fredericktown High School.
Gallatin High School.
Grant City High School.
Greenfield High School.
Greenville (Miss.) High School.
Guthrie (Okla.) High School.
Hamilton High School.
Hannibal High School.
Hardin College, Mexico.
Harrisonville High School.
Hosmer Hall, St. Louis.
Hot Springs(Ark.)High School.
Iberia Academy.
Independence High School.
Jackson Military Academy.
Jefferson High School.
Joplin High School.

Kahoka High School.
Kansas City(Kas.)High School.
Kansas City Central High School.
Kansas City Manual Training High School.
Kemper Military School, Boonville.
Kennett High School.
Keokuk (Iowa) High School.
Kewanee (Ill.) High School.
King City High School.
Kirksville High School.
Kirkwood High School.
Kirkwood Military Academy.
Lamar High School.
LaPlata High School.
Leavenworth(Kas.)High School.
Lebanon High School.
Lexington High School.
Liberty High School
Linneus High School.
Louisiana High School.
Macon High School.
Malden High School.
Marionville Collegiate Institute.
Marshall High School.
Mary Institute, St. Louis.
Maryville High School.
Mexico High School.
Michigan Military Academy, Orchard Lake, Mich.
Milan High School.
Missouri Wesleyan College.
Moberly High School.
Monroe City High School.
Montgomery City High School.
Mound City High School.
Mt. Vernon High School.
Neosho High School.
Nevada High School.
Norborne High School.
Odessa High School.
Oklahoma City (Okla.) High School.
Oregon High School.
Palmyra High School.
Paola (Kas.) High School.
Paris High School.
Pierce City High School.
Pine Bluff (Ark.) High School.
Plattsburg High School.
Pleasant Hill High School.
Poplar Bluff High School.
Princeton High School.
Quincy (Ill.) High School.
Rich Hill High School.
Richmond High School.
Ridgeway High School.
Rogers Academy, Rogers, Ark.
Rolla High School.
St. Charles High School.
St. Joseph High School.
St. Louis Central High School.
St. Louis McKinley High School.
St. Louis Manual Training School.
St. Louis Yeatman High School.
Savannah High School.
Sedalia High School.
Shelbina High School.
Shelbyville High School.
Slater High School.
Smith Academy, St. Louis.
Springfield High School.
Steelville High School.
Sweet Springs High School.
Tipton High School.
Trenton High School.
University Military School, Mobile, Ala.
Vandalia High School.
Warrensburg High School.
Washington High School.
Webb City High School.
Webster Groves High School.
Wentworth Military Academy, Lexington.
West Plains High School.
Western Military Academy.
Westport High School.
Windsor High School.

Advanced Standing.—Candidates may be admitted to "advanced standing" (that is to enter the Sophomore or the Junior class) either upon examination in the subjects of the previous year or years, or upon certificate from another institution, of work accomplished, which is, in the estimation of the Faculty, equivalent to that completed here by the class into which entrance is sought. Applicants for advanced standing should communicate with the Director as early as possible, and all claims for advanced standing, in order to receive recognition, must be made by the student within one semester after entrance.

Special Students.—Special Students will be admitted without passing the regular examinations required for entrance, under the following conditions: 1. They must be at least twenty-one years of age. 2. They must show good reasons for not taking a regular course. 3. They must pass such examinations or other tests as shall demonstrate fitness to pursue profitably all the subjects selected by them. 4. They shall not be candidates for a degree. 5. Special students are expected to do specially good work in the subjects which they choose. If, at any period of the session, their work becomes unsatisfactory, their connection with the school will be severed. When the work is chiefly of a laboratory nature they will be required to take at the same time as much class-room work as the Faculty may designate for each particular case.

Since there are many persons who would profit by the opportunities for education offered at the school, but who are unable, through lack of time or preliminary training, to undertake the work of the regular course, the Faculty has made the above provision. In this way it hopes to broaden the usefulness of the school, and to enable it to fulfill its purpose in as liberal a manner as possible.

DEGREES

1. The degree of Bachelor of Science in Mining Engineering, Bachelor of Science in Metallurgy, or Bachelor of Science in Civil Engineering, will be conferred on students who have attained the required standard in all the subjects of instruction in Courses I., II., or III., and who submit a satisfactory Thesis.

2. The degree of Bachelor of Science will be conferred on students who have satisfactorily completed Course IV. in General Science and who submit a satisfactory Thesis.

3. The degree of Master of Science will be given to students who have completed satisfactorily a year's post-graduate work in residence at the school and who have demonstrated their ability by research work and a Thesis.

4. The further degree of Engineer of Mines, Civil Engineer, or Metallurgical Engineer, will be conferred on one who, having previously been graduated in I., II., or III., has completed satisfactorily a year's post-graduate work in residence, or who has had professional experience in a responsible position for not less than three years. A satisfactory Thesis recording the result of some original investigation or independent research in a subject connected with his course, accompanied by such drawings as may be necessary to illustrate it, are required of all candidates for advanced degrees.

THESES

All Seniors carry on special investigations during the third term and the results of this work are embodied in a Thesis. The subject of the Thesis must be reported to the Thesis Committee and approved not later than February 1st and the completed Thesis filed with the Director not later than May 20th. The finished Thesis must be typewritten on eight and one-half by eleven-inch paper with a one and one-half inch margin on the left to permit of binding in book form.

COURSES OF STUDY

It is the object of the instruction at this institution, first, to lay a broad and solid foundation by acquaintance with principles and theory, and to supplement this, wherever possible, by the discipline of practical application in the laboratory and field. Lectures and recitations are arranged to come in the morning hours, leaving the afternoon for laboratory and field work. The practical work is designed to illustrate and impress principles, to familiarize the student with the use of instruments with which he is to be concerned in the work of his profession, and to afford an opportunity for original investigation. "Head-work" and "hand-work" go together. What is taught orally in the lecture room is applied and illustrated in the laboratory.

The School of Mines offers four regular courses leading to degrees:

I. *Mining Engineering.*
II. *Metallurgy.*
III. *Civil Engineering.*
IV. *General Science.*

The first is a general course in Mining Engineering having in view all of the operations in connection with Mining, from the prospecting to the delivery of the finished product on the market. Instead of the regular work outlined for the Senior year in the Mining Engineering course, a student who has satisfactorily completed the work of the first three years of this course may elect one of the three optional courses outlined on pages 52 to 54. These options are in Mining Geology, Mining Machinery, and Ore Dressing. They are planned for men who desire to specialize in the particular subjects mentioned and all lead to the degree of Bachelor of Science in Mining Engineering.

The second contemplates especially processes in Metallurgy subsequent to the delivery of the ore above ground. It

fits a man for positions in connection with concentrating plants and smelters and various branches of industrial chemistry.

The third is a course in Engineering as applied especially to Railways, Highways, and Municipal Works.

The fourth is largely elective and provides for a liberal education in General Science.

The engineering courses are practically the same in the Freshman year, and differ but slightly in the Sophomore. The student has thus an opportunity to defer his choice of a specialty until he has spent some time in technical study, and can better estimate his inclinations and capacities.

One hour is given to each recitation or lecture period. The afternoon periods are given to Drawing, Laboratory, and Field Work and are of three hours' duration.

SPECIAL COURSES

In addition to the four regular courses leading to degrees, mentioned above, a number of shorter courses are also offered. They are: *Chemistry and Assaying, Mining, Surveying and Electricity.* They have been planned for the benefit of those who, for various legitimate reasons, are unable to take the regular four-year courses.

The course in *Assaying and Chemistry* will require two years' work, although mature students, who have already some knowledge of Chemistry, may complete it in one year. For description see page 60.

The purpose of the course in *Surveying* is to develop competent land and mining surveyors and fair draughtsmen. The essentials of it are a thorough knowledge of Algebra, Trigonometry, Surveying, Field Practice, and Drawing. One school year and the first term of a second, will be required for the completion of this course.

A two years' course in *Mining* is offered to students, especially such as have had some practical experience, who may

wish to fit themselves for holding important positions about mines or in ore-dressing plants, but who are unable, on account of the lack of preparation or of time, to take the full course in Mining Engineering. Besides Mathematics this course embraces General Chemistry, Assaying, Mineralogy, Geology, Mining, Surveying, and English.

A course in *Electricity* is offered to furnish the student with the theory of Electricity, and acquaint him with its application in the arts. This subject is of prime importance to every engineer, especially to the Mining Engineer, since electricity has become such an important factor in mining operations.

See remarks on special students, page 44, and outline of special courses, page 60, et seq.

EXCURSIONS

VOLUNTARY.

A summer excursion for students who have passed their Junior work, to the deep mining district of the Rocky Mountains or Lake Superior. Geological phenomena, mines, ore dressing, and metallurgical plants will be the subjects of study.

REQUIRED.

A.—At the close of the Sophomore year, three weeks of summer field work for practice in topography and lines of communication will be required of students in Civil Engineering. This work will be carried on in the vicinity of Rolla.

B.—At the close of the Junior year, students in Mining and Metallurgical Engineering will make a four weeks' excursion to Southeast and Southwest Missouri, for the purpose of practice in mine surveying and of studying Field and Economic Geology, Mining, and Ore Dressing.

C.—An excursion by the Senior class to Steelville, Sligo, and Palmer, for the purpose of studying iron and lead deposits

and methods of reduction. This excursion will take place during the latter part of the Senior year.

D.—An excursion by the Senior class to Herculaneum, St. Louis, Granite City, and the coal fields of Illinois. This excursion will take place during the latter part of the Senior year.

E.—At the opening of the school year, in September, one week's field work in Topography by all Juniors not taking A.

COURSE I.—MINING ENGINEERING

	Time in Hours per Week		
	First Term	Second Term	Third Term
FRESHMAN YEAR			
Lectures and Recitations:			
Higher Algebra	5	0	0
Trigonometry	0	5	5
Descriptive Geometry	0	2	2
General Chemistry	5	5	4
English	5	5	5
Elementary Mining	2	0	0
Mineralogy	0	0	2
Laboratory Work:			
General Chemistry	3	3	3
Drawing, Mechanical	6	6	6
Descriptive Geometry Drawing	0	3	3
Shop Practice	6	6	0
Mineralogy Laboratory	0	0	6
SOPHOMORE YEAR			
Lectures and Recitations:			
Analytic Geometry	5	0	0
Calculus	0	5	5
Spanish, German, or French	5	5	5
English and American Literature	1	1	1
Mineralogy	2	0	0
Lithology	0	2	0
Plane Surveying	3	0	0
Mine Surveying	2	0	0
Mining	0	2	3
Elementary Mechanics	0	2	0
General Physics	0	0	5
Qualitative Analysis	0	2	0
Laboratory Work:			
Forge Shop or Machine Drawing	6	6	6
Mineralogy	6	6	0
Lithology	0	3	0
Surveying Field Practice	6	0	0
Qualitative Analysis	0	6	6
Physics	0	0	6
Topography, one week, between the Sophomore and Junior Years.			

	Time in Hours per Week		
	First Term	Second Term	Third Term
JUNIOR YEAR			
Lectures and Recitations:			
General Physics	5	0	0
Thermodynamics	0	5	0
Mechanics of Engineering	5	0	0
Mechanics of Materials	0	5	0
Hydraulics	0	0	5
General Geology	5	3	5
Quantitative Analysis	2	0	0
Assaying	2	0	0
Metallurgy	0	3	3
Masonry	0	2	0
Lines of Communication	0	0	2
Elements of Ore Dressing	0	0	3
Laboratory Work:			
Physics	6	0	0
Steam	0	3	0
Assaying	6	6	0
Quantitative Analysis	6	9	0
General Geology	0	3	6
Drawing and Graphics	0	0	6
Lines of Communication	0	0	3
Hydraulics	0	0	3
SENIOR YEAR			
Lectures and Recitations:			
Ore Dressing	4	4	4
Ore Dressing Memoirs	0	0	1
Mining Law and Contracts	2	0	0
Mine Management	0	0	2
Metallurgy	4	4	4
Metallugry Conference	0	1	0
Economic Geology	3	3	5
Dynamo Machinery	3	0	0
Alternating Current Machinery	0	5	0
Electrical Transmission	0	0	3
Compressed Air	0	2	0
Frame Structures	2	0	0
Hydraulic Motors and Pumps	0	0	1
Laboratory Work:			
Ore Dressing	9	0	6
Ore Dressing Problems	0	3	3
Graphics	3	0	0
Dynamo Machinery	6	0	0
Alternating Current Machinery	0	6	0
Electrical Problems	0	0	3
Metallurgy	0	7	0
Compressed Air	0	3	0
Thesis	0	0	6

MINING GEOLOGY OPTION

SENIOR YEAR

	Time in Hours per Week		
	First Term	Second Term	Third Term
Lectures and Recitations:			
Economic Geology	3	3	5
Petrography	3	3	2
Geology of the United States	3	0	0
Structural and Metamorphic Geology	0	0	3
Paleontology or Metallurgy	4	4	0
Historical Geology or Metallurgy	0	0	4
Geological Conference	0	2	0
Ore Dressing	4	0	0
Mining Law and Contracts	2	0	0
Methods of Prospecting and Mine Development	0	3	0
Mine Management	0	0	2
Elective Geology	0	0	3
Laboratory Work:			
Geology	3	6	6
Petrography	9	6	6
Ore Dressing	6	0	0
Paleontology or Metallurgy	0	6	0
Thesis	0	0	6

MECHANICAL HALL.

MINING MACHINERY OPTION

SENIOR YEAR

	Time in Hours per Week		
	First Term	Second Term	Third Term
Lectures and Recitations:			
Ore Dressing	4	3	3
Ore Dressing Memoirs	0	0	1
Mining Machinery	0	4	5
Dynamo Machinery	3	0	0
Alternating Current Machinery	0	5	0
Electrical Transmission	0	0	3
Compressed Air	0	2	0
Hydraulic Motors and Pumps	0	0	1
Mine Management	0	0	2
Mining Law and Contracts	2	0	0
Economic Geology	3	0	0
Metallurgy	4	4	0
Metallurgy Conference	0	1	0
Frame Structures	2	0	0
Cement and Concrete Structures	0	0	2
Laboratory Work:			
Mining Machinery	3	9	0
Mining Machinery Problems	0	0	6
Graphics	3	0	0
Dynamo Machinery	6	0	0
Alternating Current Machinery	0	6	0
Electrical Problems	0	0	3
Ore Dressing	6	0	3
Metallurgy	0	4	0
Compressed Air	0	3	0
Thesis	0	0	6

ORE DRESSING OPTION

SENIOR YEAR

	Time in Hours per Week		
	First Term	Second Term	Third Term
Lectures and Recitations:			
Ore Dressing	4	4	4
Ore Dressing Memoirs	0	0	1
Mining Law and Contracts	2	0	0
Mine Management	0	0	2
Metallurgy	4	4	4
Metallurgy Conference	0	1	0
Economic Geology	3	3	5
Dynamo Machinery	3	0	0
Alternating Current Machinery	0	5	0
Electrical Transmission	0	0	3
Compressed Air	0	2	0
Frame Structures	2	0	0
Hydraulic Motors and Pumps	0	0	1
Laboratory Work:			
Ore Dressing	9	0	6
Ore Dressing Problems	0	3	3
Graphics	3	0	0
Dynamo Machinery	6	0	0
Alternating Current Machinery	0	6	0
Electrical Problems	0	0	3
Metallurgy	0	7	0
Compressed Air	0	3	0
Thesis	0	0	6

COURSE II.—METALLURGY

	Time in Hours per Week		
	First Term	Second Term	Third Term
FRESHMAN YEAR			
Lectures and Recitations:			
Algebra	5	0	0
General Chemistry	5	5	4
English	5	5	5
Descriptive Geometry	0	2	2
Elementary Mining	2	0	0
Mineralogy	0	0	2
Qualitative Analysis	0	2	0
Trigonometry	0	5	5
Laboratory Work:			
General Chemistry	9	0	0
Mechanical Drawing	6	6	6
Qualitative Analysis	0	9	6
Mineralogy	0	0	6
Descriptive Geometry	0	3	3
SOPHOMORE YEAR			
Lectures and Recitations:			
Analytic Geometry	5	0	0
Calculus	0	5	5
German, French or Spanish	5	5	5
Elementary Mechanics	0	2	0
English and American Literature	1	1	1
General Physics	0	0	5
Lithology	0	2	0
Quantitative Analysis	2	2	2
Surveying, Plane	3	0	0
Mineralogy	2	0	0
Laboratory Work:			
Field Practice	6	0	0
Quantitative Analysis	6	9	12
Mineralogy	6	6	0
Lithology	0	3	0
Physics	0	0	6

	Time in Hours per Week		
	First Term	Second Term	Third Term
JUNIOR YEAR			
Lectures and Recitations:			
Assaying	2	0	0
General Geology	5	3	5
General Physics	5	0	0
Mechanics of Engineering	5	0	0
Chemical Memoirs	2	0	0
Electro-Chemistry	0	2	3
Mechanics of Materials	0	5	0
Hydraulics	0	0	5
Elements of Ore Dressing	0	0	3
Metallurgy	0	3	3
Physical Chemistry	0	2	0
Thermodynamics	0	5	0
Laboratory Work:			
Assaying	6	6	0
Geology	0	3	0
Field Geology	0	0	6
Physics	6	0	0
Quantitative Analysis	6	0	0
Physical Chemistry	0	3	0
Electro-Chemistry	0	3	6
Metallurgy	0	0	3
Hydraulics	0	0	3
Steam	0	3	0
SENIOR YEAR			
Lectures and Recitations:			
Alloys	2	0	0
Alternating Current Machinery	0	5	0
Dynamo Machinery	3	0	0
Electro-Metallurgy	2	0	0
Contracts	2	0	0
Metallurgical Problems	1	0	1
Metallurgy	4	4	4
Ore Dressing	4	4	3
Compressed Air	0	2	0
Metallurgy Conference	0	1	0
Metallurgical Organization	0	3	0
Electrical Transmission	0	0	3
Memoirs, Chemical and Metallurgical	0	0	1
Hydraulic Motors and Pumps	0	0	1
Technical Chemical Analysis	0	0	1
Laboratory Work:			
Metallurgy and Electro-Metallurgy	6	0	0
Ore Dressing	9	0	6
Dynamo Machinery	6	0	0
Compressed Air	0	3	0
Alternating Currents	0	6	0
Metallurgy	0	7	0
Metallography	0	3	0
Electrical Problems	0	0	3
Technical Analysis (Chemical)	0	0	3
Thesis	0	0	6

COURSE III.—CIVIL ENGINEERING

	Time in Hours per Week		
	First Term	Second Term	Third Term
FRESHMAN YEAR			
Lectures and Recitations:			
Higher Algebra	5	0	0
General Chemistry	5	5	4
English	5	5	5
Descriptive Geometry	0	2	2
Elementary Mining	2	0	0
Trigonometry	0	5	5
Mineralogy	0	0	2
Laboratory Work:			
General Chemistry	3	3	3
Descriptive Geometry Drawing	0	3	3
Mechanical Drawing	6	6	6
Shop Practice	6	6	0
Mineralogy	0	0	6
SOPHOMORE YEAR			
Lectures and Recitations:			
Analytic Geometry	5	0	0
Calculus	0	5	5
Spanish, German, or French	5	5	5
English and American Literature	1	1	1
Elementary Mechanics	0	2	0
Plane Surveying	3	0	0
Mine Surveying	2	0	0
General Physics	0	0	5
Lines of Communication	0	0	2
Geodosy	0	3	0
Laboratory Work:			
Field Practice	9	0	9
Forge Shop or Machine Drawing	6	6	0
Geodosy and Computations	0	9	0
Physics	0	0	6
Topography, one week			

	Time in Hours per Week		
	First Term	Second Term	Third Term
JUNIOR YEAR			
Lectures and Recitations:			
Astronomy	0	0	2
General Geology	5	3	5
Hydraulics	0	0	5
Mechanics of Engineering	5	0	0
Masonry	0	2	0
Mechanics of Materials	0	5	0
Metallurgy of Iron and Steel	0	0	3
General Physics	5	0	0
Lines of Communication	3	0	0
Thermodynamics	0	5	0
Roads and Pavements	0	0	2
Graphics	0	2	0
Laboratory Work:			
Drawing and Graphics	0	0	6
Hydraulics	0	0	3
General Geology	0	3	6
Field Practice	9	0	0
Engineering Laboratory and Graphics	0	12	0
Physics	6	0	0
Steam	0	3	0
SENIOR YEAR			
Lectures and Recitations:			
Alternating Current Machinery	0	5	0
Bridges (Higher Structures)	0	5	0
Compressed Air	0	2	0
Dynamo Machinery	3	0	0
Economic Geology	3	0	0
Electrical Transmission	0	0	3
Estimates and Bidding	0	0	2
Framed Structures	2	0	0
Hydraulics Motors and Pumps	0	0	1
Irrigation	0	0	3
Masonry Design and Concrete Steel	0	0	5
Mining Law and Contracts	2	0	0
River and Harbor Improvements	0	0	2
Railroad Economics	3	0	0
Sanitary Engineering	0	5	0
Water Supply	5	0	0
Laboratory Work:			
Dynamo Machinery	6	0	0
Alternating Current Machinery	0	5	0
Compressed Air	0	3	0
Designing	0	6	6
Graphics and Engineering Designs	9	0	0
Electrical Problems	0	0	3
Thesis	0	0	6

COURSE IV.—GENERAL SCIENCE

	Time in Hours per Week		
	First Term	Second Term	Third Term
FRESHMAN YEAR			
Lectures and Recitations:			
Higher Algebra	5	0	0
General Chemistry	5	5	4
English	5	5	5
Elementary Mining	2	0	0
German	0	4	4
Mineralogy	0	0	2
Trigonometry	0	5	5
Laboratory Work:			
Drawing	6	6	6
General Chemistry	3	3	3
Mineralogy	0	0	6
Elective	6	6	0
SOPHOMORE YEAR			
Lectures and Recitations:			
German	5	5	5
English	5	5	5
Elementary Mechanics	0	2	0
Qualtitative Analysis	0	2	0
Mineralogy	2	0	0
Elective	6	4	8
Laboratory Work:			
Qualitative Analysis	0	6	6
Mineralogy	6	6	0
Physics	0	0	6
Elective	9	6	3
JUNIOR YEAR			
Lectures and Recitations:			
French or Spanish	5	5	5
General Geology	5	3	5
General Physics	5	0	0
Elective	3	10	8
Laboratory Work:			
General Geology	0	3	6
General Physics	6	0	0
Elective	9	12	9

SENIOR YEAR

All Elective.

The selection of studies is subject to the approval of the faculty.

Electives after the Sophomore year must be along one of the two lines: Physics and Mathematics, or Chemistry and Geology. Twenty three hours recitation, or, eighteen hours recitation and five afternoons laboratory work constitute a course.

SPECIAL COURSE IN MINING AND ASSAYING

	Time in Hours per Week		
	First Term	Second Term	Third Term
FIRST YEAR			
Lectures and Recitations:			
Higher Algebra	5	0	0
Trigonometry	0	5	5
English	5	5	5
General Chemistry	5	5	4
Qualitative Analysis	0	2	0
Elementary Mining	2	0	0
Mineralogy	0	0	2
Elements of Ore Dressing	0	0	3
Laboratory Work:			
General Chemistry	9	0	0
Qualitative Analysis	0	9	9
Drawing, Mechanical	6	6	6
Mineralogy	0	0	6
SECOND YEAR			
Lectures and Recitations:			
Ore Dressing	4	3	0
General Geology	5	3	5
Mining	0	2	3
Assaying	2	0	0
Plane Surveying	3	0	0
Mine Surveying	2	0	0
Mineralogy	2	0	0
Lithology	0	2	0
Quantitative Analysis	2	0	0
Lines of Communication	0	0	2
Laboratory Work:			
Surveying, Field Practice	6	0	0
Ore Dressing	6	0	3
Mineralogy	6	6	0
Lithology	0	3	0
General Geology	0	3	6
Assaying	0	9	0
Quantitative Analysis	6	6	6
Lines of Communication	0	0	3

SPECIAL COURSE IN ELECTRICITY

	Time in Hours per Week		
	First Term	Second Term	Third Term
FIRST YEAR			
Lectures and Recitations:			
Higher Algebra	5	0	0
Trigonometry	0	5	5
English	5	5	5
General Chemistry	5	5	4
Electricity and Magnetism	0	3	0
Laboratory Work:			
General Chemistry	3	3	3
Drawing, Mechanical	6	6	6
Shop Practice	6	6	0
Physics	0	3	6
SECOND YEAR			
Lectures and Recitations:			
Analytic Geometry	5	0	0
Calculus	0	5	5
Elementary Mechanics	0	2	0
General Physics	5	0	5
Dynamo Machinery	3	0	0
Thermodynamics	0	5	0
Elective	3	3	6
Laboratory Work:			
Physics	9	9	9
Steam	0	3	0
Elective	6	3	6

SPECIAL COURSE IN SURVEYING

FIRST YEAR

	Time in Hours per Week		
	First Term	Second Term	Third Term
Lectures and Recitations:			
Higher Algebra	5	0	0
Trigonometry	0	5	5
English	5	5	5
Elective	5	5	5
Laboratory Work:			
Drawing	6	6	6
Field Practice	0	0	6
Elective	9	9	3

SECOND YEAR

Lectures and Recitations:

Surveying	3	hours a week.
Elective	12	" "
Field Practice	9	" "
Drawing	6	" "

GRADUATE COURSE FOR ENGINEERS *

	Time in Hours per Week		
	First Term	Second Term	Third Term
FIRST YEAR			
Lectures and Recitations:			
Mine Surveying	2	0	0
Geology	5	3	5
Mineralogy	3	0	0
Lithology	0	2	0
Qualitative Analysis	0	2	0
Assaying	2	0	0
Ore Dressing	0	0	3
Mining	0	2	3
Metallurgy	0	3	3
Elective	6	6	4
Laboratory Work:			
Mineralogy	12	6	0
Lithology	0	3	0
Geology	0	3	6
Qualitative Analysis	0	6	6
Assaying	0	0	9
Elective	3	3	0
SECOND YEAR			
Lectures and Recitations:			
Compressed Air	0	2	0
Quantitative Analysis	2	0	0
Economic Geology	3	3	5
Metallurgy	4	4	4
Metallurgy Conference	0	1	0
Ore Dressing	4	3	0
Ore Dressing Memoirs	0	0	1
Mining Law and Contracts	2	0	0
Mine Management	0	0	2
Elective	3	5	5
Laboratory Work:			
Quantitative Analysis	6	9	0
Ore Dressing	6	0	3
Compressed Air	0	3	0
Geology	3	0	3
Metallography	0	3	0
Mining Problems	0	0	3
Thesis	0	0	6
Elective	3	3	3

*This two-year course is planned for graduates in Civil, Electrical, or Mechanical Engineering, who desire to work along mining lines. The degree, Mining Engineer, will be conferred on students who have received the Bachelor of Science Degree in Engineering, and who complete the two-year course as outlined.

MATHEMATICS

PROFESSOR DEAN; ASSISTANT PROFESSOR GARRETT.

The study of Mathematics, as pursued at this school, is chiefly for the purpose of acquiring a working knowledge of its use in the subsequent studies of Engineering, Physics, and Chemistry, and not merely as a component part of a general education. Great care is accordingly exercised to insure the attainment of skill in practical applications requiring analytical powers as well as mere computation. Frequent written reviews test the proficiency of the student. Advanced standing is given only when equivalent work has been done in a School of Engineering.

1. *Graphic Algebra, Curve Tracing and Algebraic Analysis.*—This course is designed to fit students for the study of Analytic Geometry and Calculus. It embraces the following topics: Solution of quadratic equations; theory of quadratic expressions; solution of higher numerical equations, graphically and arithmetically; theory of integral algebraic functions; tracing of curves having simple numerical equations; graphical and arithmetical calculation of co-efficients of empirical formulae; convergency of infinite series; use of infinite series in approximate calculations; practical applications of the binomial theorem; errors of observation; method of least squares. Freshmen, first term, five hours a week.

2. *Plane Trigonometry.*—This subject, the most important in the mathematical equipment of the engineer, is given due prominence. The student is drilled, not only in the solution of triangles and other geometrical problems, but in the applications of the trigonometric functions in analysis and in shortening computations. The first term's work will consist of computations of parts of right triangles, with and without the aid of logarithms; the solution of oblique triangles by means of right triangles, and the derivation and use of trigonometric identities.

Freshmen, second term, five hours a week. Text-book, Crawley, *Elements of Trigonometry.*

3. *Trigonometry, Plane and Spherical.*—The more difficult parts of plane trigonometry, limits, expansion of func-

tions in series, applications of De Moivre's Theorem; spherical trigonometry, and its applications to geodesy and astronomy.

Freshmen, third term, five hours a week. Text-books: Dean, *Manuscript Notes;* Crawley, *Elements of Trigonometry.*

4. *Descriptive Geometry.*—The usual text-book is reinforced with daily blackboard exercises in presenting the projections of familiar objects, intersections of plane and curved surfaces, sections, developments, etc. The work includes perspective and shades and shadows. The afternoons in the drawing room are devoted to the solution, in neat form, of the more elaborate exercises.

Freshman year, second and third terms, two recitations a week, and three hours at the drawing board. Text: Faunce, *Descriptive Geometry.*

5. *Analytic Geometry.*—The matter and method in this course are intended to aid the student in his subsequent reading of technical literature, and in solving the problems which arise in his work in mechanics and physics. The subject is viewed from the standpoint of the engineer as nearly as possible without sacrificing its cultural value.

The work in calculus is started in the latter half of the term and carried through the differentiation of algebraic functions and their application to investigation of properties of tangents and normals and problems in maxima and minima.

Sophomore, first term, five hours per week. Text-books: Ashton, *Analytic Geometry;* Gibson, *Graphs;* Manuscript Notes.

6. *Differential Calculus.*—To the student and the engineer who is willing to take for granted the formulae worked out by other persons, the Calculus is unnecessary, but to those who wish to satisfy themselves as to the correctness of the reasoning and formulae of others, and to independent workers in Physics, Chemistry, and Mechanics, it is indispensable. This course includes: Graphic representation of functions; algebraic and geometrical limits; derivatives of algebraic functions; geometrical problems in maxima and minima involving

algebraic functions; tangents, normals and asymptotes; tracing curves having singular points; derivatives of trigonometric functions; problems in maxima and minima; kinematical problems; derivatives of inverse trigonometric functions; derivatives of complex functions; Maclaurin's Theorem and applications; Taylor's Theorem and applications; functions of two variables; tangent planes and normals.

Sophomore, second term, five hours per week. Text-books: Osborne, *Calculus; Manuscript Notes.*

7. *Integral Calculus.*—An attempt is made to ground the student so thoroughly in the integration of the functions most commonly occurring in Mechanics and Physics that he may be independent of tables of integrals. Considerable use is made of integration in series and of integration in the development of functions in series. Particular attention is given to integration as a summation.

Throughout the term the class is drilled in calculating areas, centres of gravity, moments of inertia, attractions, potential, and in solving the simpler forms of differential equations, which occur in mechanics and physics.

Sophomore, third term, five hours per week. Text-book, same as Course 6.

8. *Mechanics of Engineering.*—It is the aim in this course to develop the essential principles of mechanics and to render the student proficient in applying them to practical, rather than theoretical, problems. To this end, a large number of problems are solved, which, so far as possible, are selected from machines or structures with which the student is already familiar, or the study of which he is subsequently to take up.

Juniors, first term, five hours per week. *Maurer's Technical Mechanics* forms the basis of this course.

9. *Mechanics of Materials.*—Theory of stress, strain, and elasticity and its application to the design of members of machines and structures; a discussion of the properties of the materials of engineering construction. Some of the topics

which, for lack of time, cannot be adequately treated in the first term, are disposed of here.

Juniors, second term, five times per week. Merriman's *Mechanics of Materials,* lectures, and blackboard notes.

ELECTIVE WORK.

Students in the General Science Course who elect work in Pure Mathematics will confer with the head of the department, who will arrange work according to the needs, tastes, and aptitudes of the applicants. There is no attempt made to give *Graduate* work in this department, but any student who shows ability will be encouraged.

The following courses are offered to students who have passed all the required work in Mathematics and Mechanics, and General Physics:

1. Dynamics of Rigid Bodies.
2. Hydrodynamics.
3. Elasticity.
4. Newtonian Potential Function.
5. Harmonic Functions.
6. Least Squares.
7. Differential Equations of Mechanics and Physics.

These courses will consist of lectures based on the works of Webster, Byerly, Pierce, and Merriman, and of problems to suit the needs of the students.

CHEMISTRY

PROFESSOR GOTTSCHALK; ASSISTANT PROFESSOR THOMPSON; MR. SELTZER, MR. MANN; MR. LANE.

1. *General Chemistry.*—A comprehensive study of the general principles of Chemistry and of the more important elements. Special attention is paid to the Chemistry of the Metals. The Periodic law is followed throughout. The lectures are fully illustrated; the class is divided into several smaller sections for recitations.

Lectures and recitations, five hours a week during the first and second terms, and four hours a week during the third term of the Freshman year. Text, Gooch and Walker, *Outlines of Inorganic Chemistry.*

2. *General Chemical Laboratory.*—The laboratory work accompanying General Chemistry consists of experiments which are largely quantitative, and which are intended to teach stoichiometrical relations from the first.

One afternoon per week throughout the Freshman year for Civil and Mining Engineers and three afternoons per week during the first term, for students in the Metallurgy course and the Special Course in Mining, Surveying, and Assaying.

3. *Qualitative Analysis.*—This course includes lectures and laboratory work; the laboratory work includes the tests and separation of the more common metallic elements; analysis of solutions containing phosphates, of alkaline solutions, of insoluble substances, of alloys, of natural products, and of slags. The course also includes blow-pipe analysis.

Lectures, two hours a week during the second term of the Sophomore year, for students in Mining Engineering and in General Science, and two lectures per week during the second term of the Freshman year for students in the Metallurgy and Mining and Assaying Courses.

Laboratory work, two afternoons per week during the second and third terms of the Sophomore year, for students in Mining Engineering and in General Science; three after-

noons per week during the second term, and two afternoons per week during the third term of the Freshman year for students in Metallurgy; three afternoons per week during the second and third terms of the first year of the Special Courses in Mining and Assaying.

Text, Treadwell and Hall, *Qualitative Analysis.*

4. *Quantitative Analysis—Introductory Course.*—This work begins with a study of the balance; this is followed by accurate gravimetric analysis, first on pure soluble salts, then on natural products; then by accurate volumetric analysis (acidimetry, alkalimetry, iron by the permanganate method).

As samples of technical work, the wet assays as practiced in the west, are studied during the latter half of the course.

Lectures, two hours per week during the fall term of the Junior year for Mining Engineers, and two lectures per week during the first term of the Sophomore year for Metallurgists and students in the Special Course in Mining and Assaying.

Laboratory work for Mining Engineers, two afternoons per week during the first term and three afternoons per week during the second term of the Junior year; for Metallurgists, two afternoons per week during the first term and three afternoons per week during the second term of the Sophomore year; for students in Mining, Chemistry and Assaying, two afternoons per week during the first term and three afternoons per week during the second term of the second year.

Text, Miller, *Quantitative Analysis for Mining Engineers.*

5. *Quantitative Analysis Lectures.*—This lecture course is devoted to a complete exposition of the general methods and details of manipulation of analysis, theory of instruments used, general chemical theory not included in Freshman Chemistry, and the discussion of the sources of error, including testing, purification, and preparation of reagents.

Lectures, for Metallurgy Course, two hours per week during the second and third terms of the Sophomore year.

6. *Quantitative Analysis (Advanced).*—This course is planned to train the student in general methods of technical analysis.

Laboratory work for students in Special course in Mining, Chemistry and Assaying, two afternoons per week during the third term of the second year.

7. *Slag Analysis.*—This course presents the methods for complete analysis of slags of various kinds.

Laboratory work, Metallurgy Course, four afternoons per week during the third term of the Sophomore year.

8. *Metallurgical Analysis.*—Advanced Quantitative Analysis in its application to Metallurgy and Metallurgical Processes is presented in the laboratory.

Laboratory work, Metallurgy Course, two afternoons a week during the first term of the Junior year.

9. *Technical Analysis.*—This is an advanced and applied course in Quantitative Analysis.

Lectures, for Metallurgy Course, one hour per week during the third term of the Senior year.

Laboratory work, for Metallurgy Course, one afternoon per week during the third term of the Senior year.

10. *Chemical Memoirs.*—Carefully prepared abstracts of current articles or of special subjects are prepared by the students for this course.

Reports, for Metallurgy Course, one hour a week during the first term of the Senior year.

11. *Electro-Chemistry.*—This course includes a theoretical introduction of the study of electrochemistry and is followed by applications of principles.

Lectures, for Metallurgy Course, two hours a week during the second term and three hours a week during the third term of the Junior year.

Laboratory work for Metallurgy Course, one afternoon per week during the second term, and two afternoons per week during the third term of the Junior year.

12. *Physical Chemistry.*—This is a short course designed mainly as an introduction to the various kinds of chemical equilibria encountered in metallurgical practice.

Lectures, for Metallurgy Course, two hours a week during the second term of the Junior year.

Laboratory work, for Metallurgy Course, one afternoon per week during the second term of the Junior year.

PHYSICS

PROFESSOR MCRAE; MR. MIX.

1. *Elementary Mechanics.*—This subject includes the study of the simple machines and the fundamental principles of mechanics and hydrostatics. Lectures illustrated by experiments and recitations. Sophomores, second term, two times a week. Text-book: Merriman, *Elements of Mechanics.*

2. *Electricity and Magnetism.*—Lectures and recitations three hours a week during the second term. This course is designed as an introduction to the study of Electricity and Magnetism. Text book: S. P. Thompson, *Lessons in Electricity and Magnetism.*

3. *Laboratory Work in Electricity and Magnetism.*—Three afternoons a week throughout the year.

4. *General Physics.*—The study of Advanced Physics is taken up during the third term of the Sophomore year, and continued during the first term of the Junior. The Sophomores study kinematics, statics, kinetics, and the mechanics of fluids during the first part of the term, and conclude with the subject of Heat. The study of heat includes an introduction of thermodynamics. Particular attention is paid to harmonic motion as the basis for the study of the subjects of sound, light and alternating currents of electricity.

During the first term of the Junior year the study of Electricity and Magnetism is taken up. Such subjects as static electrification, potential, quantity, capacity, resistance, induction, impedance, inductive capacity, electric waves, etc., are studied. During the latter part of the term the reflection, refraction, diffraction and interference of Sound and Light are

studied. The entire course is illustrated by lecture experiments and supplemented by work in the laboratory. Five times a week. Text: Watson, *General Physics.*

5. *Laboratory Work in Mechanics, Sound, Light, Heat, Electricity and Magnetism.* In the laboratory, the work is quantitative and aims, as far as possible, to instruct the student in the methods of physical measurement and the derivation of relations between the quantities measured. Emphasis is laid upon the derivation of physical laws rather than the verification of them. Required of Sophomores two afternoons a week during the third term, and of Juniors two afternoons a week during the first term.

6. *Thermodynamics.*—A short course in Theoretical Thermodynamics is followed by a study of boilers, furnaces and heat engines, standard types of safety and tubular boilers, chimney and mechanical draft, pumps, heaters, etc.; steam, gas and gasoline engines are studied. Recitations and lectures are supplemented by the equivalent of one afternoon a week in the steam laboratory, where practice is had in operating and indicating engines; measuring chimney draft, boiler evaporation and the calorific value of fuels. Junior year, second term, five times a week. Laboratory, one afternoon a week. Text, Reeve, *Thermodynamics.*

7. *Dynamo Machinery.*—During the first term the Seniors meet three times a week for discussion of direct current dynamos and motors. This course includes a discussion of the magnetic circuit of dynamos and motors, with methods of connecting for operation in series and parallel; characteristic curves, methods of testing dynamos and motors, etc. Text, Sheldon, *Dynamo Machinery.*

8. *Alternating Current Machinery.*—The Seniors meet five times a week during the second term for the study of Alternating Currents and Alternating Current Machinery. Typical single and polyphase generators, synchronous and induction motors, stationary and rotary transformers, are studied; and the effect of frequency, induction, and capacity upon the

impedance of the circuit are studied by the graphical and analytical solution of numerous problems in transmission and distribution. Text, Sheldon and Mason, *Alternating Current Machinery.*

9. *Electrical Transmission.*—During the third term the Seniors meet three times a week for the study of the Electrical Transmission of energy. The course includes the continuous current circuit, single and polyphase alternating current transmission, series and parallel distribution, design of the conducting system, overhead and underground construction, etc. Lectures and recitations supplemented by one afternoon a week devoted to working out electrical problems.

10. *Dynamo Laboratory.*—The Seniors work two afternoons a week during the first and second terms in the dynamo laboratory. During the first term the work is in connection with the course in dynamo machinery, and during the second term it is in connection with the Alternating Current Machinery. The work includes calibration of instruments, characteristic curves, efficiency tests of dynamos, motors, transformers, etc., line resistance, capacity inductance, impedance, and insulation measurements, two afternoons a week during the first and second terms.

ELECTIVE WORK.

11. *Theory of Electricity and Magnetism.*—A mathematical treatment of the subject. Three hours a week during the first and second terms. Open to graduates and to advanced undergraduates. Text-book: F. E. Nipher, *Electricity and Magnetism.*

12. *Alternating Currents.*—An analytical and geometrical treatment of the subject. Two hours a week during the first and second terms. Open to graduates and to advanced undergraduates.

13. *Dynamo Design.*—This course includes the design of dynamos, motors, alternators, and transformers. Three afternoons a week during the third term. Open to those who have completed courses in 8 and 9.

CIVIL ENGINEERING

PROFESSOR HARRIS; MR. TRAMS; MR. JOHNSON; MR. BAUERIS; MR. MCCRAE.

1. *Surveying.*—This consists of a course in general surveying, including the use of the transit, the level, and the solar compass. Areas surveyed are required to be plotted to scale and the drawing completely finished in all its details. Following this work city surveying and topographic methods are taught.

Lectures and recitations, three hours a week during the first term of the Sophomore year. Text, Johnson, *Theory and Practice of Surveying.*

1a. *Field Practice.*—The students in Civil Engineering have Field Practice three afternoons per week during the first and third terms of the Sophomore year; the other students in Surveying have Field Practice two afternoons a week during the first term of the Sophomore year.

1b. *Topography.*—The students are divided into parties, each with a captain, and to each is assigned an area to be covered. One week is given to this work in the Sophomore year. From notes so taken, the Junior Civil Engineering Students are required to produce a finished topographic map.

1c. *Geodosy.*—In this course the student is taken into higher problems in Surveying, including Engineering Astronomy, Base Line Measurements, and Precise Leveling. Sophomore Civil Engineering Course, second term, three hours a week. Text, Johnson, *Theory and Practice of Surveying.*

1d. *Geodosy, Computations and Drawings.*—In this course the student is exercised in mapping and platting in the determination of areas, and partition of land, and learns to systematically work up the problems in Geodosy. Sophomore (C. E.) year, second term, three afternoons per week.

2. *Lines of Communication.*—This course covers the mathematical problems in the location of railways, highways, and canals, and in setting out and estimating earthwork, laying out track, and locating tunnels.

Lectures and recitations, two hours a week, during the third term of the Sophomore year, for Civil Engineers and two hours a week for the third term of the Junior year for Mining Engineers. Text, Nagel, *Manual of Field Engineering.*

Field Practice, three afternoons a week during the third term of the Sophomore year of Civil Engineers, and one afternoon a week during the third term of the Junior year of Mining Engineers.

3. *Railway Economics.*—This course treats of the economic principles of railway location and improvements of old lines as affected by curvature grades, first cost, cost of maintenance, and traffic.

Lectures and recitations, two hours a week during the first term of the Senior year, Civil Engineering Course. Text, Webb, *Railway Economics.*

4. *Masonry Construction.*—The course treats of the economic properties of building stone, brick, and cements; the proportioning, mixing and placing of mortars and concrete; preparations of foundations and strength and stability of masonry structures, including dams, piers, abutments, retaining walls, and arches.

Lectures and recitations, two hours a week during the second term of the Junior year. Text, Baker, *Masonry.*

5. *Engineering Laboratory.*—This includes tests determining the strength and properties of building materials of various kinds, including stone, brick, cement, concrete, cast iron, steel, and wood. Special attention is paid to tests of cements and cement mortars, and concretes.

Two afternoons a week during the second term of the Junior year. (C. E.)

6. *Roads and Pavements.*—A course discussing the principles involved in the location and construction of highways, street and roads, and the merits of the various methods of paving.

Lectures and recitations two hours a week during the second term of the Junior year. (C. E.)

7. *Cement and Concrete Structures.*—This course treats of the higher structures in Masonry, including arches, dams, and portals, and the art and theory of "Concrete Steel" structures. The properties, uses and economy of cement are discussed. The student is required to prepare drawings and specifications of as many such structures as the time available will permit.

Lectures and recitations for Civil Engineering students, five hours a week during the third term of the Senior year; for Mining Engineering students, two hours a week during the third term of the Senior year. Text, Turneaure and Russel, *Reinforced Concrete.*

8. *Hydraulics.*—A course covering the theory of Hydrostatics and of Hydraulics; determination of experimental coefficients and their use as applied to the flow of water through orifices, weirs, pipes, and canals. Also the theory of hydraulic motors and dynamic pumps.

Lectures and recitations, five hours a week during the third term of the Junior year.

Laboratory work, one afternoon a week during the third term of the Junior year. Text, Merriman, *Hydraulics.*

9. *Water Supply.*—A course covering the selection, imponding, transporting, and delivering of water supply to cities and towns.

Lectures and recitations, five hours a week during the first term of the Senior year. (C. E.)

Text, Turneaure and Russel, *Water Supply.*

10. *Sanitary Engineering.*—A course treating of the necessary precautions for the protection of water supplies from pollution and the methods available for the purification of contaminated supplies; the principles involved in the collection and disposal of sewage and storm waters.

Lectures and recitations, five hours a week during the second term of the Senior year. (C. E.).

Text, Folowill, *Sewage of Cities.*

11. *Irrigation.*—A short course designed to bring out the essential details of the location of canals, headworks, impounding reservoirs, and supplementary work.

Lectures and recitations, three hours a week during the third term of the Senior year. (C. E.).

Text, Wilson, *Irrigation Engineering.*

12. *River and Harbor Improvements.*—A course treating of the control of flood water, protection of river banks, improvement of navigation, and protection and improvement of harbors.

Lectures and recitations, two hours a week during the third term of the Senior year. (C. E.).

13. *Frame Structures.*—This course, designed alike for students in Mining and Civil Engineering, treats of general methods of determining stresses in such structures as single span bridges, roof trusses, towers, derricks, and of the design of individual members, as posts, beams, and rods, to carry specified stresses.

Lectures and recitations, two hours a week during the first term of the Senior year.

Text, Merriman and Jacoby, *Stresses in Simple Trusses.*

14. *Bridges* (*Higher Structures*).—This course is for students in Civil Engineering only and carries them into the study of arches and cantilever, swing, and suspension bridges.

Lectures and recitations, five hours a week during the second term of the Senior year. (C. E.)

Text, Merriman and Jacoby, *Higher Structures.*

15. *Drawing and Graphics.*—Students in Civil Engineering are required to complete a topographic map during the Junior year. This is followed by an exercise in the elementary problems of graphic statics as applied to single-span bridges and roofs and to masonry structures.

Four afternoons a week during the second term of the Junior year, two afternoons during the third term of the Junior year, and three afternoons in the first term of the Senior year. (C. E.)

Text, Merriman and Jacoby, *Graphic Statics.*

16. *Engineering Designs.*—The Senior students in Civil Engineering devote three afternoons a week during the first and second terms to designs in some line of engineering, such

as steel bridges, concrete steel structures, water supplies, sewage systems, or the like.

17. *Special Investigations (Thesis).*—In the third term of the Senior year all graduating students give two afternoons a week to original investigation in some subject which they select, with the approval of the Faculty.

18. *Compressed Air.*—A course covering the laws governing the compression and piping of air and the application of compressed air to the industries.

Lectures and recitations, two hours a week during the second term of the Senior year.

Laboratory, one afternoon a week during the second term of the Senior year.

19. *Astronomy.*—A course in general astronomy is given for students in Civil Engineering.

Lectures and recitations, two hours a week during the third term of the Junior year. (C. E.)

Text, Young, *General Astronomy.*

MINING ENGINEERING

PROFESSOR LITCHMAN AND DIRECTOR YOUNG.

The School of Mines and Metallurgy offers a regular four-year course in Mining Engineering. At the beginning of the Senior year three options are offered in place of the Senior Course of Study in the regular Mining Engineering Course:

1. **Mining Machinery.**—This Option is designed for those students who desire to specialize along the mechanical side of Mining Engineering. Less time is given to Metallurgy and Geology and more time to Machine Problems and Laboratory.

2. **Ore Dressing.**—This Option is designed for those students who desire to specialize in Concentration of Ores. More time is given to Ore Dressing, both theoretical and applied, with a correspondingly longer time for Laboratory work. Less attention is paid to Geology than in the regular course.

3. **Mining Geology.**—This option is designed for those students who desire to specialize along the geological side of mining and gives less time to Metallurgy and Ore Dressing and more time to Geology.

The Options lead to the common degree of B. S. in Mining Engineering. The course of study includes the following subjects:

1. *Elementary Mining.*—This short course outlines the principles on which the science of Mining Engineering is founded, and is designed to introduce the student to fundamentals which will enable him to appreciate the applications of the other studies of the Freshman and Sophomore years.

Lectures, all Freshman, two hours a week during the first term.

2. *Mine Surveying.*—The theory and the practice of the surveying of mineral lands and mines are presented by lectures. Many problems are introduced and the student is trained in various calculations, including the reduction of notes of underground surveys requiring the auxiliary telescope, volumes of stopes, mineral acreage, intersections of veins, underground connections, and general problems in the determination of the location of mine openings. A Mine Surveying Trip to the Joplin District is a required part of the work of the Junior year.

Lectures and recitations, Mining Engineering Course, two hours a week in the first term of the Sophomore year.

3. *Mining.*—This course includes lectures on Prospecting, Drilling, Blasting, Boring, Tunnelling, Shaft-Sinking, and Mining Methods. The various tools and appliances used in these operations are described. A review of methods of Mine Timbering is included in the course.

Lectures and recitations, two hours a week during the second term of the Sophomore year, for Mining Engineering Course.

4. *Mining.*—This course is a continuation of Course 3 and includes lectures on Mine Haulage, Hoisting, Mine Drainage, Mine Ventilation, Lighting, Accidents, and Hygiene.

Lectures and recitations, Mining Engineering Course, three hours a week during the third term of the Sophomore year.

5. *Elements of Ore Dressing.*—A course in the principles of the mechanical movements underlying the operation of Ore Dressing Machinery. The course consists of a series of lectures on Shafting, Pulleys, Belting, Power Transmission, and Mechanical Movements for obtaining uniform, intermittent, and variable motions; a short discussion of the more common fittings used in the transmission of air and steam, and a brief description of the various machines and apparatus in use for the crushing, classification, and concentration of the more important ores. Numerous problems are given the students to illustrate the principles discussed.

Lectures: Three lectures per week, third term, Junior year, Metallurgy Mining Engineering, and Special Course in Mining, Chemistry and Assaying.

Text: Richards, *Ore Dressing.*

6. *Junior Trip.*—At the end of the school year the members of the Junior class make a four-weeks' trip to the mining districts of Southeast and Southwest Missouri. The purpose of the trip is to give an opportunity for the study of the methods of mining and the concentration of ores in the districts visited, together with work in Mine Surveying and Geology.

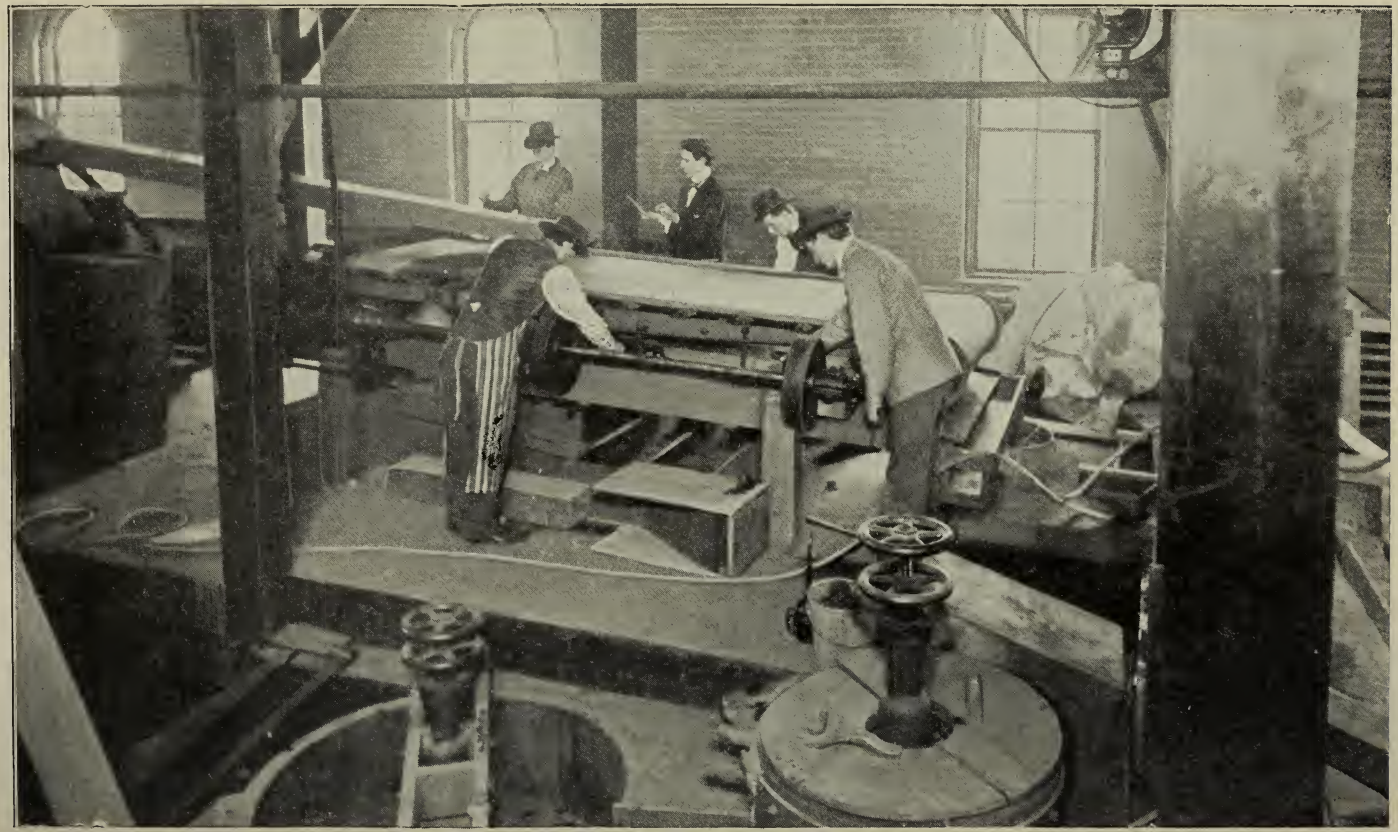
A complete report of the work of the trip is required.

7. *Ore Dressing.*—This course presents the principles, methods, and mechanical appliances in use to-day for crushing, classifying, and concentrating important ores. The course must be preceded by Elements of Ore Dressing, and includes a practical discussion of the various principles of Ore Dressing, and Ore Dressing Machinery.

Numerous problems are given the student, showing the applications of the principles discussed.

Lectures and recitations, Mining Engineering and Metallurgy Courses, four hours a week during the first term and three hours a week during the second term of the Senior year.

Text: Richards, *Ore Dressing.*



ORE DRESSING LABORATORY

8. *Ore Dressing Laboratory*—(a). The object is to give the student experience in the more common methods of Ore Dressing, treated in the discussions, and to afford practice in the application of principles to the production of useful results. Two afternoons per week, first term, Senior year, for Mining Engineering and Metallurgy Courses.

Ore Dressing Laboratory—(b). Involves the application of Ore Dressing principles to some specific problems of ore treatment. It includes the working out of a practical method for the solution of the problem, together with plans, drawn to scale, showing the arrangement of the plant designed, and specifications giving the kind and amount of machinery and material used. One afternoon per week, third term, Senior year.

Ore Dressing Laboratory—(c). In addition to the Laboratory work (see Course 8a) of the regular Mining Engineering Course, the students taking the Ore Dressing Option do extra work in the Ore Dressing Laboratory. This consists in part of testing ores to determine a process of treatment, mill sampling, and tests of the quality of the work of different machines under varying conditions.

Laboratory work, Ore Dressing Option and Metallurgy Course, three afternoons per week during the first term and two afternoons per week during the third term of the Senior year.

9. *Mining Law and Contracts.*—The general principles of Mining Law are reviewed with discussions of legal decisions in representative cases. The students are given the general principles governing the making of contracts, together with discussions of contracts typical of various mining districts.

Lectures, Civil Engineering, Mining Engineering, and Metallurgy Courses, two hours a week during the first term of the Senior year.

10. *Mine Management.*—This course is planned to give the student an idea of the principles of management of mining enterprises, and reviews methods of mine organization, mine

accounting, and presents economic problems in connection with mine management. The practice of mine examination and mine reporting is reviewed.

Lectures, Mining Engineering Course, two hours a week during the third term of the Senior year.

Text: Richard, *Economics of Mining;* Richard, *Ore Sampling.*

11. *Mining Problems.*—Each student is assigned several problems which occur in connection with mining operations and in the installation of mining equipment.

Mining Engineering Course, one afternoon per week during the third term of the Senior year.

12. *Mining Machinery Laboratory.*—Prior to undertaking laboratory work on special mining machinery, the student is given a thorough training in the machine shop. This work includes chipping to a line, filing to a dimension, and scraping to a surface plate; the principles and uses of the drill-press, planer, lathe, shaper, and milling machine. In this work use is made of the vernier micrometer, thread micrometer, and gear-tooth caliper. The degree of accuracy thus acquired enables the student to use eye and hand in unison and is of lasting benefit in teaching exactness in statement and measurement.

Special attention is given to various types of mining machinery and to the study of steel and other materials which enter into the construction of such machinery.

Laboratory work, Mining Machinery Option, one afternoon per week during the first term and three afternoons per week during the second term of the Senior year.

13. *Mining Machinery.*—This course includes an outline of the various types of machinery used in mining operations and is planned to familiarize the student with the best designs of machinery in order that he may be able to select the proper machine for the particular condition, that he may know when each machine operates efficiently, and know how to keep the machine in a first-class condition.

The machinery studied includes rock drills, coal cutters, mine hoists, mine pumps, mine locomotives, wire rope haulage

systems, mine fans, excavating machinery, and safety appliances.

Lectures and recitations, Mining Machinery Option, four hours per week during the second term and five hours per week during the third term of the Senior year.

14. *Mining Machinery Problems.*—This course is a continaution of Course 12, and includes advanced work in the Machine Shop in connection with Mining Machinery. The methods of testing various machines under working conditions are presented and whenever possible such tests are carefully carried out underground.

Laboratory work, Mining Machinery Option, two afternoons per week during the third term of the Senior year.

15. *Ore Dressing.*—This is an advanced course supplementing the regular course in Ore Dressing (Course 7). It discusses in detail the theory of the various machines used in crushing, classifying, and concentrating ores, reviews magnetic separation, and considers thoroughly certain special problems.

Lectures and recitations, Ore Dressing Option in Mining Engineering to be taken at the same time with Course Seven.

16. *Ore Dressing Memoirs.*—The student in Ore Dressing is required to do considerable technical reading and prepares carefully abstracts of articles appearing in the technical periodicals and magazines. Articles of special interest in Ore Dressing are assigned for the weekly conference.

Reports, Mining Engineering Course and Ore Dressing Option, one hour a week during the third term of the Senior year.

17. *Ore Dressing Problems.*—This is advanced work in connection with the design of plants and machinery for the treatment of ores tested in the laboratories.

Drafting Room Work, Ore Dressing Option, one afternoon per week during the second term and one afternoon during the third term of the Senior year.

GEOLOGY AND MINERALOGY

ASSISTANT PROFESSOR GRISWOLD; MR. COREY; MR. DON.

1. *Mineralogy.*—The course consists of lectures and laboratory work during one year, beginning in the third term of the Freshman year. Crystallography is studied first and is followed by the investigation of the physical characters of the minerals. Special emphasis is given to the ores, gangue minerals, non-metallics of economic value, and the rock forming silicates.

Lectures, two hours a week during the third term of the Freshman year and two hours a week in the first term of the Sophomore year. Laboratory work, two afternoons a week during the third term of the Freshman year and two afternoons per week during the second and third terms of the Sophomore year.

Text: Dana, *Mineralogy.*

2. *Lithology.*—The course is elementary in character; the igneous rocks are studied with reference to texture and mineral composition, and the sedimentary rocks with reference to structure and composition.

Lectures, two hours a week during the second term of the Sophomore year.

Laboratory work, one afternoon per week for the second term of the Sophomore year.

Text: Kemp, *Handbook of Rocks.*

3. *Petrography.*—The subject is divided into Optical Mineralogy and Lithology. The igneous rocks are first studied, then the sedimentary and the metamorphic rocks. The course is designed to meet the needs of the mining engineer and the mining geologist. A large amount of time is devoted to the study and determination of hand specimens.

Lectures, three hours per week during the first and the second terms and two hours per week for the third term of the Senior year, in the Mining Geology Option.

Texts: Kemp, *Handbook of Rocks*; Iddings, *Rock Minerals.*

4. *General Geology.*—This is a lecture course devoted to the principles of general and economic geology. It discusses the evolution of the earth, its present condition, and the processes which have modified its crust and surface.

Lectures, five hours during the first term, three hours during the second term, five hours during the third term of the Junior year.

5. *General Geology Laboratory—Structural Geology.*—The student has work upon geological models, maps, and photographs with the view to interpreting geological structures and land surface forms. One afternoon a week during the second term of the Junior year.

Field Work.—The student visits various localities near Rolla with the instructor and has the various types of geology explained; then he is assigned an area to map geologically.

Two afternoons a week, or the equivalent in time, during the third term of the Junior year.

The course is supplemented by the summer field excursions to Southeast and Southwest Missouri.

6. *Economic Geology.*—This is a series of lectures dealing with the occurrence, origin, and distribution of ores, clays, building stones, gems, water supply, and other products of economic value from the different geological formations. The characteristics and genesis of ore deposits are carefully considered. The members of this class visit local points of economic importance near Rolla, studying iron, lead, coal, clay, building stone, etc., besides making an excursion to the zinc-lead district of Joplin.

Text: Ries, *Economic Geology of the United States.*

Lectures, three hours a week during the first and second terms and five hours a week during the third term of the Senior year.

7. *Geology of the United States.*—This lecture course considers the various geologic and physiographic provinces of the United States and adjacent areas in their relation to geological development and economic interest. Optional for Seniors, three times a week during the first term.

8. *Geological Conference.*—The conference is devoted to discussion by the students and instructors of geological literature or problems associated with extra reading or with the laboratory work of the term.

Optional for Seniors, two hours a week during the second term.

9. *Structural and Metamorphic Geology.*—In this course various type regions of the world will be studied in detail with reference to structure, to metamorphism, and to their combinations.

Optional for Seniors, three hours a week during the third term.

10. *Senior Geological Laboratory*—(A). During the first term of the Senior year, one afternoon per week will be given to mapping a local area, the resulting map to be accompanied by a geological report. Required of all Seniors in the Mining Engineering Course.

(B). This will include the drawing of maps and sections and some experimental work, planned with reference to the Geological Conference (Course 8) and to Structural and Metamorphic Geology (Course 9). Two afternoons per week during the second term of the Senior year.

(C). Excursions to various localities of economic interest within easy reach of Rolla. One afternoon per week for all mining engineers, with another afternoon optional during the third term.

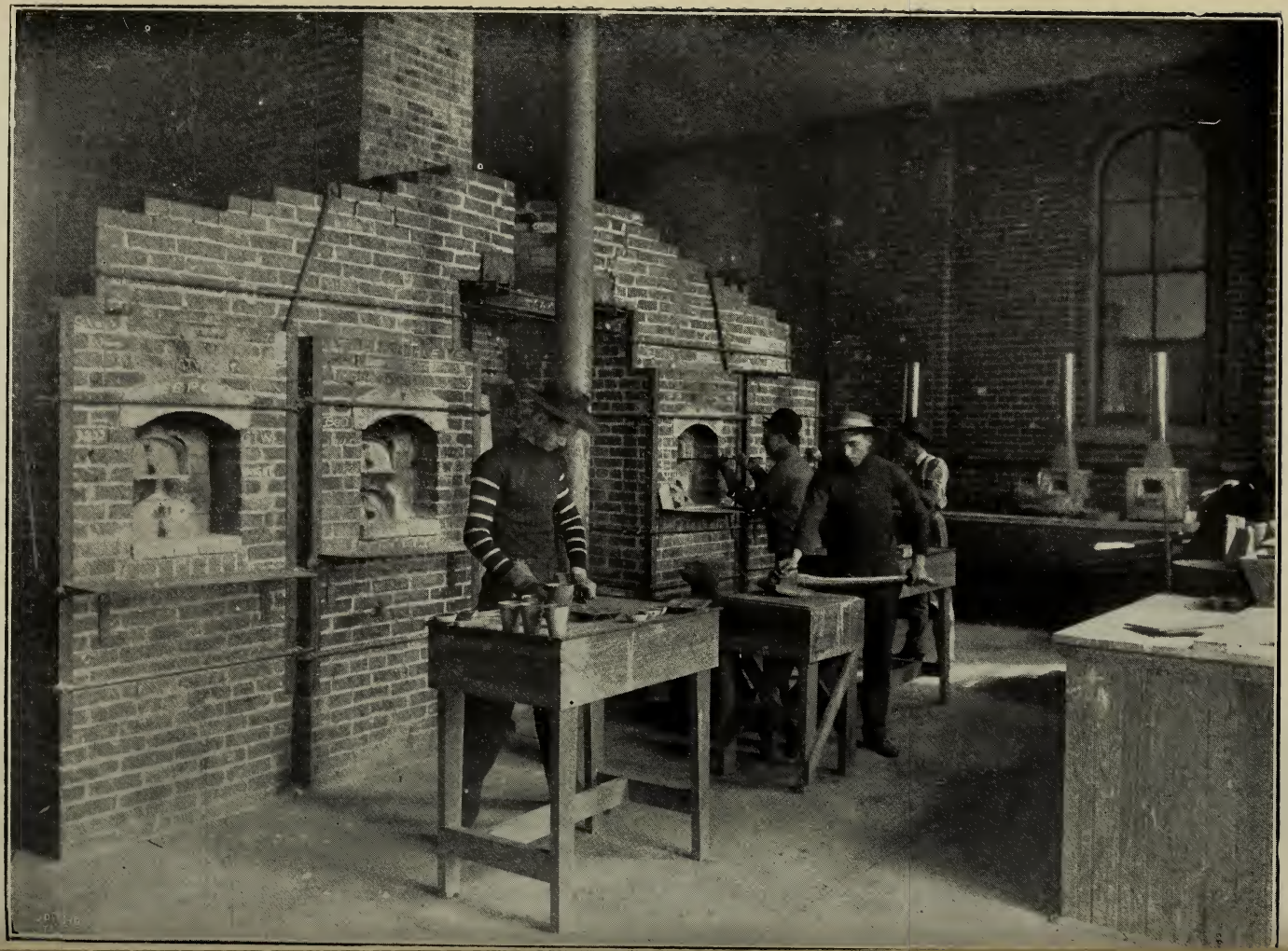
11. *Paleontology.*—The course is designed to serve as an introduction to historical geology.

Text: Zittel, *Paleontology.*

Lectures, four hours per week during the first and second terms of the Senior year. Laboratory work two afternoons per week during the second term of the Senior year.

12. *Historical Geology.*—The stratigraphical development of the United States is taken up in as much detail as time permits.

Lectures, four hours per week during the third term of the Senior year.



ASSAYING LABORATORY

METALLURGY

PROFESSOR COPELAND; MR. DUDLEY; MR. ANDERSON.

The work in this department is designed to give students a thorough training in all branches of Metallurgy.

It is recognized that a school cannot give students, in the brief time at its disposal, that skill which comes from long practice, but it is the aim of the department to give such training in the fundamental principles and their application, that students may become useful immediately on their entrance into the actual practice of their chosen profession. All metallurgical courses are accompanied by graded metallurgical problems, which give the student a technical command of the subject.

An important feature of the instruction in this department is experimental investigation in the metallurgical treatment of various ores.

For convenience in recording and reporting, the subjects following are classified under the general letter M, with necessary subdivisions.

M.—1. *Fire Assaying.*—Scorification and crucible assays of gold and silver ores, assays of copper matte, combination assay of copper mattes, and copper ores for gold and silver; assay of lead, silver, and gold bullions; assay of cyanide solutions for precious metals; corrected assays of high-grade precious metal products; fire assay for lead.

The laboratory course is supplemented by lectures. The nature of the processes is thoroughly explained and practical difficulties discussed. Two afternoons per week, first and second terms of the Junior year. Lectures two hours per week during the first term.

Text-Book: Lodge, *Notes on Assaying.*

M.—2. *General Metallurgy and Metallurgy of Iron.*—This course begins with general principles including properties of metals and alloys, fuels, fluxes, calculation of charges, general study and classification of furnaces, followed by a study of processes employed for the production of cast iron, wrought iron and steel.

Text: Hofman, *Notes on Steel.*

Reference Books: Roberts-Austin, *Introduction*; Howe, *Metallurgy of Steel*; Campbell, *Steel.*

Juniors, second and third terms, three hours per week. The Seniors of the C. E. Course are given special work.

M.—3. *Metallurgy of Lead and Silver.*—Lectures and recitations.

Hofman's *Metallurgy* is used as a text for lead and desilverization of base bullion, and Collins' *Metallurgy of Silver* for wet processes of silver extraction.

Seniors, first term, four hours per week.

M.—4. *Metallurgy of Copper, Nickel, Mercury, Tin, Antimony.*—Peter's *Metallurgy of Copper* is used as a reference book and is followed by lectures on the other metals named, with Schnabel's *Metallurgy* for reference.

Seniors, second term, four hours per week.

M.—5. *Metallurgy of Gold and Zinc.*—Lectures and recitations.

Text-Book: Rose, *Metallurgy of Gold.* For reference on zinc, Ingall, *Metallurgy of Zinc and Cadmium.*

Seniors, third term, four hours per week.

M.—6. *Constitution of Alloys.*—Lectures dealing with the theoretical and practical considerations that influence the structure and properties of alloys of different types.

Lectures and recitations two hours per week, first term of the Senior year for Metallurgical students.

M.—7. *Electro-Metallurgy.*—Lectures are given covering the Electrometallurgical processes that are in use. Efficiency and Engineering calculations based on this and the required courses above mentioned.

Lectures and recitations two hours per week during the first term of the Senior year of the Metallurgy course.

M.—8. *Metallurgical Organization.*—The course briefly takes up the principles of organization, and the duties of officers and accounting force of a Metallurgy plant. The outline shows the extent of the course. Organization of companies and working forces, management, superintendence, skilled and

WOOD SHOP

unskilled labor. Then following this, the constitution of capital; stocks, bonds, dividends, and profits.

Lectures and recitations three hours per week during the second term of the Senior year in the Metallurgy course.

Text: Conyngton, *Corporate Management.*

M.—9. *Metallurgical Problems.*—These problems aim to cover the common ones that the Metallurgist meets in practicing his profession. They are carefully chosen so as to represent as typical cases as possible.

Lectures, one hour per week during the first and third terms of the Senior year of the Metallurgy course.

Text: Richards, *Metallurgical Problems.*

M.—10. *Memoirs.*—The student in the Metallurgy course is required to do a considerable amount of technical reading in German and English. Carefully prepared abstracts of valuable current articles are presented and read by the students themselves. These articles are chosen by reason of having special value along Chemical or Metallurgical lines.

Reports, one hour per week, during the first term of the Senior year, Metallurgical course.

M.—11. *Metallurgy Conference.*—Laboratory Course, M.—13, is accompanied by weekly conferences. These are of great value to the student and aid him materially in getting the full value of his laboratory work.

One hour per week, second term, Senior year.

M.—12. *Metallurgical Laboratory.*—This course aims to familiarize the student with the use of calorimeters and pyrometers, and their calibration. Some insight is given into the ordinary methods of Metallurgical investigation, and the methods of measurement, that a Metallurgist should know how to conduct.

Juniors, Met. course, third term, one afternoon.

Text-Book: Howe, *Laboratory Notes.*

M.—13. *Metallurgical Laboratory.*—This course covers the testing of ores for process of treatment. Ores are tested by cyaniding, chlorination, amalgamation, lixiviation, concen-

tration, and by combination methods. With aid of smelter schedules, the smelting costs are calculated and the net dollars and cents returns are balanced against the best results by any method, or combination of methods, worked out in the laboratory. The endeavor is made, not only to teach metallurgical principles in the laboratory, but also to bring home to the student the great effect which freight rates, etc., might have on the treatment which an ore should receive.

Experiments are made in reverberatory and "pot" roasting of ores, ond on blast furnace smelting of ores.

Furnace heat equations are made by each student from data collected by himself.

Seven hours' Laboratory Work during the second term of the Senior year, in the Mining and Metallurgical Courses.

Text: Howe, *Laboratory Notes.*

Weekly conference, one hour per week. (See Metallurgy Conference, M.—11.)

M.—14. *Metallography.*—Study of the microstructure of iron and steel and of the effects of heat treatment.

Laboratory work, one afternoon per week, during the second term of the Senior year in the Mining and Metallurgy Courses.

M.—15. *Metallurgical Problems.*—This course has reference to the designing and proportioning of various types of furnaces for special duties and conditions. It will call for a clear conception of metallurgical principles.

The Alternative, Electrometallurgical Problems will cover the design and estimates for a copper or copper-nickel refinery.

M.—16. *Electro-Metallurgy Laboratory.*—This course gives a study of the principles of electrometallurgy from the standpoint of experiments actually performed. Tests are made on the electrolytic refining of copper and of lead bullion. Experiments are performed, and calculations as to efficiency are made on electric smelting.

Seniors, Metallurgy Course, two afternoons a week for the first term.

FORGE SHOP

SHOP PRACTICE AND DRAWING

ASSISTANT PROFESSOR BOWEN; MR. SMITH.

1. *Wood Work.*—The work in this course begins with simple exercises in planing and marking with the gage and knife. It continues until the pupil has become thoroughly familiar with the use of the plane, bevel, square, gage, and knife. He is then given graded exercises covering rip and cross-cut sawing and sawing to a "fit." Following this comes work at joints designed to show the different methods of construction, glue joints, doweling, dove tails and braces. This work is supplemented by talks on the tools and work in hand, and each student is required to pass a written examination on notes covering the classification and use of hand tools and accessories.

This preliminary work is followed by the construction of a drawing desk of our own design, which is a very rigid and substantial individual desk. It is designed for two sections, each student having a separate drawer and locker for instruments and drawing board, where they are free from disturbance and dust. Following the desk comes Wood Turning, which is designed to familiarize the student with the use of the lathe. He is given graded exercises, beginning with a plane cylinder, embracing curves of various kinds and sizes, and ending with face plate work in rings, balls, goblets and vases. On all the preliminary work students are required to use the tools in such a way as to make the use of sand paper unnecessary.

A final part of this course is cabinet making, designed to give the student work on the planer, universal saw table, wood trimmer, scroll-saw and mortise machine. After becoming familiar with the different machines pattern-making is begun. The purpose of this work being to teach the student to make representative types of patterns from which castings may be made. The principles of the shrink rule are explained and drawings, such as are used in manufacturing plants, are made in order

to teach the use of the finish marks, core boxes, and all conventional signs.

All work is done from drawings.

Freshman Class, two afternoons per week, the first and second terms.

2. *Forge Work.**—This course begins with simple exercises in drawing, upsetting, bending, twisting, punching and welding. The work gradually becomes more difficult, such as making eye bolts, chains, tongs, etc. Tool making is then begun by making screw drivers, hammers, chisels, and a complete set of lathe tools, which will be used later in the machine shop. This work is fully illustrated by drawings and lectures on the subject, covering the properties of the different grades of iron and steel. Great care is exercised to make the student familiar with the best grade of steel to be used for any required purpose, and the correct shape and temper necessary for the best work in cutting iron, steel, brass, stone, etc. The final and most important part of this work is the testing of Rock Drills of different makes, care being exercised to preserve the results of the tests on different grades and makes of steel used.

Sophomore class, two afternoons per week throughout the year.

3. *Metal Work.*—This course begins with chipping to a line, filing to a dimension and scraping to a surface plate. Machine operation is then begun, the principles and uses of the drill-press, lathe, planer, shaper and milling machine are taught by lectures followed by practical work at each machine. After a reasonable time skill is attained in operating the various machines through a course of graded exercises. Students are required to build complete machines designed by upper classmen or by the instructor. In this work use is made of the vernier micrometer, thread micrometer and gear-tooth caliper. The degree of accuracy thus acquired enables the student to

*Students may elect three terms' work of Machine Drawing instead of three terms in Forge Work.

DRAWING ROOM

use eye and hand in unison, and is a lasting benefit in teaching exactness in statement and measurement.

This is a part of the course in Mining Machinery Laboratory, described as Course 12 in Mining Engineering.

4. *Mechanical Drawing.*—The student is first given practice in geometrical construction until he is familiar with the nature, care and use of drafting instruments. Then, after carefully studying the principles of orthographic projection, intersection and development, he is thoroughly drilled in free hand lettering. The course is completed with one term of machine drawing. In this the student is required to make sketches, detail and assembly drawings of machines, and is taught the principles of elementary machine design.

Freshman year, six hours per week throughout the year.

Text: Anthony, *Mechanical Drawing*; Wilson, *Free Hand Lettering*; Anthony, *Machine Drawing.*

5. *Machine Drawing.**—This course is a continuation of the work in Mechanical Drawing of the Freshman year. It includes exercises covering gearing, power transmission, mechanism, and the simpler machines used in Mining, Ore Dressing, and Metallurgy.

Sophomore class, two afternoons per week throughout the year.

ENGLISH

MR. SCOTT.

There is a growing appreciation of the value, in practical affairs, of the ability to use language with ease, clearness, and forcefulness. The importance of English composition as a mental gymnastic is being acknowledged as never before, and, more and more, instructors in technical schools are recognizing the fact that it is an essential part of an engineer's education.

1. *Theme Work.*—All freshmen in this Institution are required to write, throughout the year, short, daily, and long

*Students may elect three terms' work in Forge Work instead of three terms' work in Machine Drawing.

fortnightly themes. This work is carefully criticised by the instructor, corrected by the student and returned to the former as evidence that the student has profited by the criticisms.

2. *Rhetoric.*—Lectures and Recitations. This work is designed as a continuation of the subject as taught in the high schools of the State, Freshman, five times a week throughout the year.

Text-Books: Brewster, *Representative Essays on the Theory of Style,* and Baldwin, *College Manual of Rhetoric.*

3. *English and American Literature.*—All Sophomores are required to study English and American Literature throughout the school year. At least two British or American classics will be studied each term. Themes that will test the character of the student's interpretation of these productions will be required.

Lectures and Recitations once a week throughout the Sophomore year.

MODERN LANGUAGES

MR. WILKINS.

The great quantity and worth of the technical literature in the French and German languages, added to their value as elements of liberal culture, make at least a reading knowledge of them practically a necessary part of an engineer's education.

The instruction in each language is designed to present the grammatical structure and the pronunciation of the tongue, to give some acquaintance with the masterpieces of its literature, and to confer such facility in translation as will enable the student to read with ease the language in both its literary and its scientific uses.

German.—(Elementary, for such students who elect German as the foreign language in their course, and who have not had at least *one year* of High School German.)

Keyser and Monteso, *German Grammar.*

Four times per week throughout second and third terms of the Freshman year.

German (Scientific).—Dippold's *Scientific German Reader,* current scientific journals and magazines.

Five times per week throughout Sophomore year.

French (Scientific).—Herdler's *Scientific French Reader,* current scientific journals and magazines.

Five times per week throughout Sophomore year.

Students who have not had Elementary French will not be permitted to elect this language.

Spanish.—The growing demand for Mining Engineers and Metallurgists in South and Central America, in Mexico and the Philippines, where a knowledge of Spanish is almost an essential qualification, has been met by the establishment of a course in this language in the School of Mines. The natural or conversational method is followed exclusively.

Hills and Ford's *Spanish Grammar,* and lectures.

The object is to give the student facility in the every-day speech of the people.

Five times per week throughout Sophomore year.

With the consent of the faculty, students may elect Spanish as the required modern language.

GENERAL INFORMATION

TERMS AND VACATION

The college year, consisting of thirty-eight weeks, exclusive of the Christmas Holidays, is divided into three terms. The first term begins September 22 and ends December 22; the second term begins January 5 and ends March 20; the third term begins on the 22d of March and closes on the 9th of June.

The Christmas Holidays intervene between the first and second terms, but there is no interruption of work between the second and third terms. Thanksgiving Day and Washington's Birthday are observed as single holidays.

EXCURSIONS

The State of Missouri occupies an important place in the Mining Industry and many opportunities are offered students at the School of Mines and Metallurgy for keeping closely in touch with the Mining Industry of Missouri and adjoining States. There have been many important developments during the last few years in methods of Mining, Dressing, and Smelting lead and zinc ores. The Lead District of Southeast Missouri and the Zinc District of Southwest Missouri offer numerous examples of up-to-date practice in Mining and Metallurical Engineering. The aggregate tonnage capacity of the concentrating plants of Missouri is greater than that of any other State of the Union. The importance of modern methods of Ore Dressing is everywhere recognized and the facilities offered by the School of Mines for investigation in Ore Dressing, together with the practice in concentrating plants which are visited, places the School of Mines and Metallurgy in the foremost rank in this important branch of Mine Engineering.

Frequent trips and excursions give the student an opportunity to study Mining, Ore Dressing, and Metallurgical methods. Field work in Metal Mine Surveying is carried on in suitable mines conveniently located in Southeast and Southwest Missouri. The practice in Coal Mine Surveying is usually given in one of the Northern Missouri Coal Mines or in the Illinois Field.

The Junior trip, taken immediately after Commencement, includes visits to both Southeast and Southwest Missouri. In the former district, the Geology, Methods of Mining, and the Milling of great disseminated Lead Deposits are studied.

The Geological work of the Junior trip is especially valuable because of the variety of work introduced. The class has an opportunity to study several varieties of pre-Cambrian rocks of igneous and other origin. Differentiation in magma and intrusions can be seen. The pre-Cambrian topography is discernible in relation to the contact plane between the pre-Cambrian and Cambrian. Evidence of superimposed drainage is offered. Iron ores of Shepard Mountain, Pilot Knob, and Iron Mountain, give interesting study in the distribution of

and origin of ores. The general relation of the lead ores of the Paleozoic is also studied. The weathering of various kinds of rock in conjunction with joining and stratification is well illustrated. The Carboniferous Basin about St. Louis is given a brief examination. The student should be provided with notebook, compass, clinometer, hammer, and magnifying glass. The observation work of the day is supplemented by evening conferences.

The Concentrating Plants of Southeast Missouri are large and modern, containing Crushers, Rolls, Elevating Machinery, Wilfley Tables, Freu Vanners, Jigs, and sundry other machines. The mining plants are thoroughly modern and include Steam and Electric Hoists, Modern Steel Head Frames, Compressed Air and Electric Haulage, Extensive Pumping Plants, and numerous Diamond Drill Prospecting Equipments.

In Southwest Missouri the Geology, Mining, and Milling of the shallow deposits as well as of "Sheet" Ground are studied. Opportunity is given to inspect and study the various types of equipment and methods as adapted to shallow and deeper mining. Many new concentrating plants have been erected and are strictly modern in design and equipment. The application of electric power to mining and milling is well illustrated in this district. Short trips are made to neighboring camps in Southeastern Kansas.

Special attention is paid on these trips to general engineering problems, plant design, economy of operation, and organization.

During the Senior year several trips are made to the metallurgical plants in the vicinity of St. Louis. The plant of the St. Louis Blast Furnace Company illustrates blast furnace practice. Here may be studied the Blast Furnace, Regenerative Stoves, Blowing Machinery, Power Plant, and other appliances necessary for the production of pig iron. Open Hearth Steel Methods and the manufacture of Steel Castings is studied at the Scullin and Gallagher Works. This plant includes in addition to the usual type of Open Hearth Furnace, Bessemer Converters, Cupolas, and Gas Producers.

The Metallurgy of Zinc is studied at the Edgar Zinc

Works at Carondelet, where the Roasting of Blende and Distillation methods may be seen. The Federal Smelter, at Alton, is visited for the study of Lead Smelting. At this plant the Lead Blast Furnace, the Huntington Heberlein Roasting System, and the Scotch Ore Hearths are carefully inspected. This plant also includes an extensive Bag House. The manufacture of white lead paint and of lead pipe is seen at the National Lead Works. A further study of lead smelting is made at Herculaneum, where blast furnaces are served by Savelsberg Pot Roasters. At the various plants enumerated, particular attention is paid to the construction of furnaces, the operation of the plant, and the general organization and design.

The manufacture of refractory materials is carefully followed from the mine to the finished product at the plant of the Laclede-Christy Co. This plant is one of the largest clay manufacturing works in the world, and a Metallurgist here has a splendid opportunity to investigate refractory products and materials used in the construction of furnaces, stacks, retorts, and crucibles.

These excursions are a required part of the courses and no substitutions are allowed. Every candidate for a degree must take the prescribed excursions as scheduled.

STUDENT ORGANIZATIONS

The following chapters of college fraternities exist at the School: Gamma Chi of Sigma Nu, Beta Alpha of Kappa Alpha, Beta Chi of Kappa Sigma, Alpha Kappa of Pi Kappa Alpha, and Missouri Beta of Tau Beta Pi.

The Young Men's Christian Association was organized in the College several years ago, and is growing rapidly. It stands for the best there is in college life and brings together those who believe that college men should develop well rounded characters, physical, mental, and spiritual. During the opening days of the college, trains will be met by association members, who place themselves at the service of the new men, helping them to secure rooms and board and to matriculate. The Association occupies the second floor of the Metal-

VIEW ON CAMPUS

lurgy Building, where all students are welcomed and regular meetings are held.

The School of Mines Band furnishes music for athletic and outdoor functions and maintains a splendid organization.

The School of Mines Orchestra is reputed throughout south central Missouri as without equal and furnishes music for all School entertainments, the Commencement Exercises, and gives concerts in nearby towns.

Other Student Organizations include the Glee Club, the Mandolin Club, the Mathematical Club, and the International Club.

ATHLETICS

The School encourages rational athletics. Occasional privileges are granted to athletic teams, but prolonged absences from work are not permitted.

An athletic field has been enclosed and graded for baseball, football, and other games, and an ample number of tennis courts have been laid out, and are maintained in good order. Suitable dressing rooms and shower baths are provided in a temporary building on the Athletic Field. A gymnasium is provided on the second floor of Mechanical Hall. Suitable gymnasium apparatus is supplied and indoor games can be carried on during the winter months. A general athletic association exists among the students, also football and baseball teams, and a tennis club.

Athletic Fee.—Each student is requested to pay a fee of Five Dollars to the Athletic Association of the School.

EXPENSES

Laboratory Fees.—The Board of Curators, at a meeting held in December, 1898, voted to make tuition free, and to abolish the entrance fees which have hitherto been charged. The fixed charges remaining, are: A Library fee of $5 per year, payable upon entrance; a laboratory fee in General Chemistry, to cover the cost of gas and supplies, $3 per term for all courses except Metallurgy and Special Mining, for which courses the fee is $10; a laboratory fee in Qualitative

Analysis of $7.50 per term to cover the cost of general supplies and gas; a laboratory fee for Quantitative Analysis and other Senior and Junior Chemical Laboratory work, $1.75 per term; a fee of $2.50 per term to cover the cost of supplies, for Shop Work; a fee of $2 per term to cover the cost of supplies in Forge Work; a laboratory fee of $12.50 per term to cover the cost of supplies in Assaying; a laboratory fee of $3 per term to cover the cost of supplies in Mineralogy; a fee of $5 per term for Senior Metallurgy Laboratory; a fee of $2.50 per term for Mining Machinery Laboratory.

The above charges are made on the basis of the actual average cost per student for supplies in the respective courses, at wholesale rates.

Excursion Expenses.—The cost of field excursions will average about $35 per year.

Contingent Deposits.—Deposits, to cover the cost of extra supplies, damage to apparatus, etc., are required of the different classmen as follows: Freshmen, $10; Sophomores, Juniors, and Seniors, $15. These deposits must be renewed if at any time exhausted, and at the end of the school year whatever sum may remain to the credit of the depositor is returned to him.

No distinction, in admission or charges, is made between residents of this State and those of any other State or Country.

Living Expenses.—The cost of living in Rolla is low. Board, including lodging, meals, fuel and lighting, may be had in private residences or at the hotels for from $18.00 to $20.00 per month.

The expenses of many students for the entire school year do not exceed $225.00, and $250.00 will cover, in a reasonable manner, the fees, and the cost of books, stationery, board, lodging, fuel, lights, and washing. The cost of field excursions is not included in the above estimate.

BUREAU OF GEOLOGY AND MINES

The Geological Survey of the State of Missouri has its quarters at the School of Mines and occupies the east half of the Rolla Building.

BOARD OF MANAGERS.

Governor Joseph W. Folk, ex-officio; Professor E. M. Shepard, Springfield; Elias S. Gatch, St. Louis; Stonewall Pritchett, Webb City; L. T. Cottey, Edina. Terms expire May 22, 1909.

OFFICERS OF THE GEOLOGICAL SURVEY

E. R. Buckley, Ph. D., State Geologist.
Mrs. W. R. McCaw, Stenographer.

EQUIPMENT

The Survey has well equipped quarters in the Rolla Building on the School of Mines campus, and is furnished heat and light by the School.

The Survey has under its control at the present time a library of five thousand books and pamphlets bearing on Geological subjects, and a museum collection of nearly six thousand specimens of the various clays, coals, fossils, and other geological products of the State. The Geological Survey carries on systematic field work throughout the State by means of its efficient corps of geologists. Reports of this work are printed for distribution among parties interested. Geological maps of the State and a number of districts have been prepared.

GIFTS TO THE SCHOOL OF MINES AND METALLURGY

Acheson Graphite Co., Niagara Falls, N. Y.—Graphite Products.
Aluminum Co. of America—Set of Aluminum Samples.
Carnahan, H. T., Mfg. Co., Denver, Colo.—Drill Sharpening Equipment.
Castner Electric Alkali Co.—Exhibit of Caustic Soda.
Cleveland Pneumatic Tool Co., Cleveland, Ohio—One No. 10 Hammer Drill, complete (loan).
Connersville Blower Co., Connersville, Ind.—Section of Model Blower and Pump.
Crane Co., St. Louis, Mo.—Sectioned Valves.
Crocker-Wheeler Co., Chicago, Ill.—Lantern Slides of Electrical Machinery.
Davenport Locomotive Works, Davenport, Iowa.—Two Framed Pictures.
Granby Mining and Smelting Co., Granby, Mo.—Samples of French Drill Steel.
Hancock Inspirator Co., Chicago, Ill.—Sectioned Standard Type Inspirators.
Hardsocg Wonder Drill Co., Ottumwa, Iowa.—Drill.
Hendey Machine Co., Terrington, Conn.—Framed Photographs.
Herrington & King Perforating Co., Chicago, Ill.—31 Samples of Mining Screens.
Hitchcock, C. K.—Geological Collection from Northern Michigan.
Hoyle, Chas., El Oro, Mexico—115 kilo. Ore for Metallurgical Laboratory.
Jenkins Bros., Chicago, Ill.—Pump Valves, Discs, Packings.
Jones, J. W., Webb City, Mo.—Collection of Analyzed Zinc Ores.
Keuffel & Esser, St. Louis, Mo.—Large Model Slide Rule.
Liddell, T. Parker, Manhattan, Nev.—Maps Manhattan District.
Ludlow-Saylor Wire Co., St. Louis, Mo.—76 Samples of Wire Cloth.
Lunkenheimer Co., Cincinnati, Ohio—Set of Sectional Valves, Injectors, Cups and Lubricators.
Metallic Cap Mfg. Co.—Samples of Blasting Caps.
Mercer, H. T., Painesdale, Mich.—Specimens of Copper Arsenides.
Morgan Construction Co., Worcester, Mass.—One Framed Wall Picture.
Morse-Williams & Co., Philadelphia, Pa.—Exhibit, Worm Gear.
Michigan Pipe Co., Bay City, Mich.—Sample Piece of Wood Pipe.
New York Belting and Packing Co., New York, N. Y.—Rubber Belting, Air Hose, Steam Hose.

Neptune Meter Co., New York, N. Y.—One Meter.
Northern Electric Mfg. Co., St. Louis, Mo.—Photographs of Electrical Machinery.
Pennsylvania Salt Mfg. Co., Philadelphia, Pa.—One Framed Wall Picture.
Peck, F. S., Deadwood, S. D.—3 Maps of the Black Hills.
Platt, H. W., Leadville, Colo.—One Map of the Leadville District.
Porter, H. K. & Co., Pittsburg, Pa.—3 Photographs.
Putnam Machine Co., Fitchburg, Mass.—Framed Photographs.
Reed, F. E. & Co., Worcester, Mass.—Framed Photographs.
Swedish Iron & Steel Co., New York, N. Y.—Samples of Drill Steel.
Underhill, Dr. James, Idaho Springs, Colo.—2 Maps of the Clear Creek District.
Waring, W. G., Webb City, Mo.—Zinc Ores.
Wellman-Seaver-Morgan, Cleveland, Ohio—6 Photographs.
Woodward & Powell Planer Co., Worcester, Mass.—Framed Photographs.
Worthington, Henry R. & Co., New York, N. Y.—One Set Working Drawings of Pumping Machinery.

CONFERRING OF DEGREES

ENGINEER OF MINES

Stanley Ralston Moore.

METALLURGICAL ENGINEER

Evans Walker Buskett.

BACHELOR OF SCIENCE (Mine Engineering)

Arnold George Baker,
Albert Babbitt Bartlett,
William Ernest Brown,
Paul Richardson Cook,
Aubrey P. Fellows,
William Peter Hatch,
James Carter Long,
Walter Coffran Richards,
John Payne Sebree,
Tsik Chan Tseung, M. D.,
Edwin Richard Wash,
Ira Lee Wright.

BACHELOR OF SCIENCE (Civil Engineering)

Eldon Everett Cook,
John Thomas Vitt,
William Crutcher Perkins.

BACHELOR OF SCIENCE (Chemistry and Metallurgy)

John Theo. Emanuel Ericson,
Walter Irving Phillips,
Byron John Snyder,
Sakuhei Sunada,
Andrew Jackson Seltzer.

BACHELOR OF SCIENCE (General Science)

John Bennett Scott.

THESES IN 1907

Treatment of a Low Grade Gold Ore,
Paul R. Cook, Sakuhei Sunada, and Arnold P. Barker.

Lime Roasting of a Copper Concentrate and Treatment in the Blast Furnace,
Frank L. L. Wilson, William E. Brown, and Walter C. Richards.

Lime Roasting of a Galena Concentrate with Subsequent Smelting in the Blast Furnace.
Tsik C. Tseung, James C. Long, Aubrey P. Fellows, and Edwin R. Wash.

Efficiency of Mill Practice in the Joplin District,
Ira L. Wright.

Design of a Lead Blast Furnace,
Walter I. Phillips and Andrew J. Seltzer.

Sewage System for Plattsburg, Missouri,
William C. Perkins and Eldon E. Cook.

Curves Representing Compressed Air Formulae,
John T. Vitt.

Design of a Stamp Mill and Cyanide Plant,
John P. Sebree and William P. Hatch.

The Composition and Analysis of Zinc-Lead Pigment,
Evans W. Buskett.

Report on Polaris Mine, - - - Stanley R. Moore.

The Comparison of Meridian Instruments and Methods,
Albert B. Bartlett.

Analyses of Limestones, Shales, and Mineral Waters,
Byron J. Snyder.

Physical and Chemical Analysis of Steel,
John Theodore E. Ericson.

STUDENTS AT THE MISSOURI SCHOOL OF MINES AND METALLURGY

1907-1908

GRADUATES.

Brown, Joseph Jarvis, Jr.....Cuba City, Wis.
Chamberlain, Harry Carleton .....Gila Bend, Ariz.
Duncan, Gustavus A. .....Boston, Mass.
Gregory, James Albert .....Monterey, Mexico.
Heck, Elmer Cooper .....Hermisillo, Mexico.
Hoffman, Ray Eugene .....Hannibal, Mo.
Laizure, Clyde McKeever .....Millers, Nev.
Nesbitt, William Corsey .....Soda Springs, Idaho.
Wilfley, Clifford Redman.....Maryville, Mo.

SENIORS.

Armstrong, Richard Edward .....Howell, Mich.
Baker, Charles Armstrong .....Fort Madison, Ia.
Barrett, Edward Phillip .....Hastings, Neb.
Benedict, Ralph Robert .....Kansas City, Mo.
Bowles, John Hyer.....Rolla, Mo.
Boyer, George Hewitt..... St. Louis, Mo.
Dudley, Boyd, Jr. .....Gallatin, Mo.
Flint, Frank LeRoy .....Rolla, Mo.
Fowler, James Duncan .....Hughesville, Mo.
Harper, Frank William .....Dallas, Texas.
Hase, Herman Carl .....Kansas City, Mo.
Hynes, Dibrell Pryor .....Fort Smith, Ark.
Johnson, Horace Asahel.....Brookfield, Mo.
Kellogg, George Fred .....Skidmore, Mo.
Klockmann, Otto Ernest.....St. Louis, Mo.
Lyneman, Felix Anthony .....Denver, Colo.
Mann, Horace Tharp .....Canon City, Colo.
Mapes, Harold Thomas .....La Cananea, Sonora, Mex.
Mix, Ward Barr .....Hailesboro, N. Y.
Moore, Frederick Arnold .....Rolla, Mo.
Murray, Edwin Phelps .....Lake City, Mich.
Neer, Don Morgan .....Winfield, Kas.
Nye, Alfred Leo .....Kearney, Neb.
Philippi, Paul Andrew .....St. Louis, Mo.
Sandford, John Joseph .....Dansville, N. Y.
Sedivy, Miles .....Cleveland, Ohio.
Thornhill, Edwin Bryant .....Gray Summit, Mo.
Wood, Clyde Rex .....Sheridan, Wyo.

JUNIORS.

Anderson, Hector George Sylvester.. Detroit, Mich.
Baueris, William Albert ..... Chicago, Ill.
Boyer, Fred. T. ..... St. Louis, Mo.
Butler, Reginald Henry Brinton..... Leeds, England.
Cavazos, Enrique ..... Saltillo, Mexico.
Chamberlain, Ernest Lorenzo ..... Rolla, Mo.
Chinn, Raleigh Walter Corbert..... Hannibal, Mo.
Clarke, William Daniel ..... Rolla, Mo.
Clark, William Newton ..... Jewel City, Kas.
Compton, James Crawford ..... Independence, Mo.
Dobbins, Walter ..... Champaign, Ill.
Don, DeForrest ..... Rock Island, Ill.
Dunn, Theodore S. ..... Waukegan, Ill.
Easley, George A. ..... Walker, Mo.
Elicano, Victoriano ..... Masinloc, Zambales, P. I.
French, Charles Lewis ..... St. Louis, Mo.
Garst, Harvey Oden ..... Cabool, Mo.
Hall, William Simpson ..... Pleasanton, Kas.
Ham, Roscoe Conkling ..... Kansas City, Mo.
Hinsch, Van Buren ..... Davenport, Ia.
Illinski, Alexis Xavier ..... Nashville, Tenn.
Judy, Philip Smith ..... Camp Point, Ill.
Kendrick, Robert Thomas ..... St. Louis, Mo.
Kenniston, Carl Winthrop..... Plymouth, N. H.
Kibe, Harry Clay..... Socorro, New Mexico.
Ladd, Hammond ..... Rolla, Mo.
Langsdale, Byron Withers ..... Kansas City, Mo.
Leming, Paul Bauchmann ..... Cape Girardeau, Mo.
Loveridge, Frank Richard ..... Batavia, N. Y.
McCrae, Rowe Francis ..... Rolla, Mo.
Mazany, Mark Stephen ..... Dunkirk, N. Y.
Michael, Pearl Frederick ..... Rolla, Mo.
Mook, Robert Lee ..... St. Louis, Mo.
Nachtmann, Frank ..... Junction City, Kas.
Ohnsorg, Norman Lloyd ..... Rolla, Mo.
Poindexter, Urban Hatfield ..... Kansas City, Kas.
Pollard, Arthur Lewis ..... Batavia, N. Y.
Radovich, John Christopher ..... Bisbee, Ariz.
Ross, Donald ..... Independence, Kas.
Seamon, William Henry, Jr. ..... Chihuahua, Mexico.
Shah, Aaron ..... Vilna, Russia.
Spoffard, Howard Nelson ..... St. Louis, Mo.
Talwar, Fatch Chand ..... Gujranwala, India.
Walker, Leland Ross ..... St. Louis, Mo.

Wander, Ernest ..... Chicago, Ill.
Watson, Ralph Wilheim ..... Salt Lake City, Utah.
Whitener, Oscar Miles Cornelius..... Fredericktown, Mo.
Wishon, Albert Emory ..... Fresno, Cal.
Wolf, Edgar Joseph ..... Mt. Vernon, Ind.

SOPHOMORES.

Allen, Robert Sexton ..... Kansas City, Mo.
Blake, Frank Orris, Jr. ..... Pittsburg, Pa.
Blaylock, Daniel Webster ..... Flat River, Mo.
Bowles, James Joseph ..... Rolla, Mo.
Bunten, James ..... Canon City, Colo.
Burdick, Charles Adrian ..... Dansville, N. Y.
Clark, John Charles ..... Chicago, Ill.
Connelly, Harry Wade ..... Independence, Kas.
Coon, Arthur Clemons ..... Kansas City, Mo.
Detweiler, Alfred Nicks ..... Lebanon, Mo.
Detweiler, Milan Harrison ..... Lebanon, Mo.
Diaz, Emilio ..... Santiago, Chili.
Dosenbach, Benjamin Harrison..... St. Louis, Mo.
Drake, Robert Lemon ..... Kansas City, Mo.
Dye, Robert Emmet ..... Joplin, Mo.
Dykes, Guy ..... Rolla, Mo.
Farrar, Monroe ..... Mattoon, Ill.
Flynn, Milton ..... Monterey, Mexico.
Forman, John Kavenaugh..... McFall, Mo.
Fraser, Keith Colt ..... Lyndonville, N. Y.
Garnett, Roscoe A. ..... Pueblo, Colo.
Garza, Antonio ..... Saltillo, Mexico.
Gray, Howard Dean ..... Wausem, Ohio.
Gregory, Clay, Jr. ..... Joplin, Mo.
Harlan, John Dee ..... Moberly, Mo.
Harris, Walter Theodore ..... Salt Lake City, Utah.
Harrison, Walter Edward ..... Salem, Mo.
Hill, Fred Wilson ..... Mt. Vernon, Ia.
Holmes, Oliver Wendell ..... Rolla, Mo.
Humphrey, Brighton W. ..... Rolla, Mo.
Insley, Earl Frank ..... Kansas City, Mo.
Jobes, Charles Taylor ..... Kansas City, Mo.
Karte, Anton F. ..... De Soto, Mo.
Killian, Ralph Daniel ..... Perryville, Mo.
List, Elmer ..... Cape Girardeau, Mo.
McNutt, Vachel Harry ..... Monroe City, Mo.
Menefee, George Gilmore ..... Stanford, Ky.
Miller, Christian R., Jr..... Sedalia, Mo.

Minor, Harmon Edwin ..... Canon City, Colo.
Morgan, Allen Ray Dearborn..... Rolla, Mo.
Palomares, Rodolfo de S..... Mexico City, Mexico.
Park, Albert ..... Rolla, Mo.
Peeso, William D..... Junction City, Kas.
Peterson, Howard K. ..... New Rochelle, N. Y.
Philips, Ralph N. ..... Chicago, Ill.
Pierce, Colwell Arba ..... Kansas City, Mo.
Porri, Louis Joseph ..... St. Louis, Mo.
Porth, Harry William ..... Kansas City, Mo.
Ramey, Corey Floyd ..... Georgetown, Ky.
Schmidt, Sidney Randolph ..... Chicago, Ill.
Smith, Earl McCulloch ..... Little Rock, Ark.
Smith, Harvey Edson ..... St. Louis, Mo.
Smith, Van Hoose ..... Little Rock, Ark.
Stewart, John Sloane, Jr. ..... Mansfield, Ohio.
Thornberry, Martin Hermon ..... Rolla, Mo.
Traughber, Charles W. ..... Centralia, Mo.
Twyman, George Thomas, Jr..... Independence, Mo.
Valencia, Carlos ..... Sutlan, Jalisco, Mexico.
Vogt, George C. ..... Davenport, Ia.

FRESHMEN.

Abbott, Edward Reese ..... Mansfield, Ohio.
Abernathy, George Elmer ..... Willow Springs, Mo.
Adams, Henry Farnum ..... Prescott, Ariz.
Allen, Ernest ..... Forrest, Ill.
Ball, Ralph Harlan ..... Gardner, Kas.
Beach, James Keller ..... Kansas City, Mo.
Bingham, Raymond Alexander ..... Watertown, Mass.
Blake, True Walter ..... Maywood, Ill.
Boza, Hector ..... Lima, Peru.
Bradt, Albert Leonard ..... St. Louis, Mo.
Burgher, Clarence ..... Rolla, Mo.
Caplan, Frank ..... St. Louis, Mo.
Caples, Russell Bigelow, Jr..... Glasgow, Mo.
Carroll, Roland Tregoe ..... Baltimore, Md.
Chase, James Howard ..... Logansport, Ind.
Coaske, Paul E. ..... St. Louis, Mo.
Cody, Benjamin Horace ..... St. Joseph, Mo.
Coover, Louis Lincoln ..... Springfield, Mo.
Copeland, Robert Nathaniel ..... Chelsea, Mass.
Curless, Thomas ..... Liberal, Mo.
Daves, Lee Colburn ..... St. Louis, Mo.
Deacon, Arthur ..... St. Louis, Mo.

Diaz, Washington Theodore ..... Santiago, Chili.
Elmore, Carlos Enrique ..... Lima, Peru.
Englemann, E. W. ..... Cape Girardeau, Mo.
Flynn, Francis James ..... St. Joseph, Mo.
Ford, Harold Percy ..... St. Joseph, Mo.
Forrester, David L. ..... Oakland, Cal.
Garcia, Emilio ..... Rinconada, Mexico.
Garcia, Herman ..... Rinconada, Mexico.
Garza, Andres ..... Saltillo, Mexico.
Grosberg, Alex. ..... St. Louis, Mo.
Harris, D. Deane ..... Rolla, Mo.
Heydecker, Carroll T. ..... Waukegan, Ill.
Jett, Daniel Boone ..... Sedalia, Mo.
Jones, Howard Hiltz ..... Mexico City, Mexico.
Jones, Kenneth Hugh ..... Lawrence, Nebr.
Kline, Duane Montgomery ..... Rolla, Mo.
Kurz, Adolph ..... St. Louis, Mo.
List, Edgar ..... Cape Girardeau, Mo.
Lunak, Otto Allen ..... St. Louis, Mo.
McGoughran, James ..... New York, N. Y.
Macomber, Sumner Cooley ..... Des Moines, Ia.
Mann, Frank Clark ..... Springfield, Mo.
Martin, Harry H., Jr..... Fredericktown, Mo.
Mitchell, Robert Bruce ..... Walker, Mo.
Moore, Lloyd Weaver ..... Hannibal, Mo.
Nachtmann, Ralph ..... Junction City, Kas.
Nason, Stanley L. ..... West Haven, Conn.
Parent, George E..... Marshall, Mo.
Pudewa, Arthur ..... Chicago, Ill.
Radcliffe, Donald Hewson ..... Webster Groves, Mo.
Raj, Shio ..... Lahore, India.
Randolph, Oscar Alan ..... Kansas City, Mo.
Smith, George Randall ..... Utica, Mo.
Smith, James Wickliffe, Jr..... Miller School, Va.
Stroup, Thomas Andrew..... Lewistown, Mo.
Swenson, Howard Hubard ..... Torreon, Mexico.
Taylor, Clarence Merlin ..... Jackson, Mo.
Townsend, Frank Edgar ..... Belgrade, Mo.
Wheeler, Joseph Franklin ..... Marshall, Mo.
Williams, Conway Guild ..... Jackson, Mo.
Wolf, Harold M. ..... Mount Vernon, Ind.

SPECIALS.

Baumgardner, Julius Ward ..... Abingdon, Ill.
Beckner, Fred. Goodrich ..... San Antonio, Texas.
Bedford, Arthur Hardy ..... Auckland, New Zealand.

Brown, Hamlin	Lake Springs, Mo.
Chew, Lindell	St. Louis, Mo.
Espriu, Rafael	Mexico City, Mexico.
Goldman, Jay Maurice	St. Louis, Mo.
Jones, William Hamilton	St. Louis, Mo.
deJong, E. T.	St. Louis, Mo.
Owen, Harvey Skidmore	St. Louis, Mo.
Pilcher, Aubrey Gaybert	St. Louis, Mo.
Renfrow, Thomas Owen	Rolla, Mo.
Riede, Fred Edward	Canon City, Colo.
Shockley, Percy C.	Monterey, Mexico.
Siegmund, Walter	St. Louis, Mo.
Smith, Duncan	Rockford, Ill.
Stahl, William Glenroy	Little Rock, Ark.
Tomlinson, Edward Loraine	El Paso, Texas.
Townsend, Richard Henry	Aspen, Colo.
Vogt, John Gerheart, Jr.	Trenton, Ill.
Weems, Frank Eugene	Sulphur, Okla.

STATES.

Arizona	3
Arkansas	4
California	2
Colorado	7
Connecticut	1
Idaho	1
Illinois	17
Indiana	3
Iowa	5
Kansas	10
Kentucky	2
Maryland	1
Massachusetts	3
Michigan	3
Missouri	111
Nebraska	3
Nevada	1
New Hampshire	1
New Mexico	1
New York	9
Ohio	4
Oklahoma	1
Pennsylvania	1
Tennessee	1
Texas	3
Utah	2
Virginia	1
Wyoming	1
Wisconsin	1
Total	203

FOREIGN COUNTRIES.

Chili	2
England	1
India	2
Mexico	16
New Zealand	1
Peru	2
Philippine Islands	1
Russia	1
Total	26

MISSOURI BY COUNTIES.

Barton	1
Boone	1
Buchanan	3
Cape Girardeau	6
Davies	1
Dent	2
Franklin	1
Gentry	1
Greene	2
Howard	1
Howell	1
Jackson	15
Jasper	2
Jefferson	1
Laclede	2
Lewis	1
Linn	1
Livingston	1
Madison	2
Marion	3
Monroe	1
Nodaway	2
Perry	1
Pettis	3
Phelps	20
Randolph	1
St. Francois	1
St. Louis City	27
St. Louis County	1
Saline	2
Texas	1
Vernon	1
Washington	1
Total	111

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